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Original Paper

Associations Between Immigration-Related User Factors and eHealth Activities for Self-Care: Case of First-Generation Immigrants From Pakistan in the Oslo Area, Norway

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Abstract

Background: Immigrant populations are often disproportionately affected by chronic diseases, such as type 2 diabetes mellitus (T2DM). Use of information and communication technology (ICT) is one promising approach for better self-care of T2DM to mitigate the social health inequalities, if designed for a wider population. However, knowledge is scarce about immigrant populations' diverse electronic health (eHealth) activities for self-care, especially in European countries.

Objective: With a target group of first-generation immigrants from Pakistan in the Oslo area, Norway, we aimed to understand their diverse eHealth activities for T2DM self-care in relation to immigration-related user factors specific to this target group: proficiency in relevant languages (Urdu, Norwegian, English), length of residence in Norway, and diagnosis of T2DM compared with general user factors (age, gender, education and digital skills, and self-rated health status).

Methods: Data were from a survey among the target population (N=176) conducted in 2015-2016. Using logistic regression, we analyzed associations between user factors and experiences of each of the following eHealth activities for T2DM self-care in the last 12 months: first, information seeking by (1) search engines and (2) Web portals or email subscriptions; second, communication and consultation (1) by closed conversation with a few acquaintances using ICT and (2) on social network services; and third, active decision making by using apps for (1) tracking health information and (2) self-assessment of health status. Using Poisson regression, we also assessed the relationship between user factors and variety of eHealth activities experienced. The Bonferroni correction was used to address the multiple testing problem.

Results: Regression analyses yielded the following significantly positive associations: between Urdu literacy and (1) information seeking by Web portals or email subscriptions (odds ratio [OR] 2.155, 95% CI 1.388-3.344), (2) communication and consultation on social network services (OR 5.697, 95% CI 2.487-13.053), and (3) variety (estimate=0.350, 95% CI 0.148-0.552); between length of residence in Norway and (1) communication and consultation by closed conversation with a few acquaintances using ICT (OR 1.728, 95% CI 1.193-2.503), (2) communication and consultation on social network services (OR 2.098, 95% CI 1.265-3.480), and (3) variety (estimate=0.270, 95% CI 0.117-0.424); between Norwegian language proficiency and active decision making by using apps for self-assessment of health status (OR 2.285, 95% CI 1.294-4.036); between education and digital skills

and active decision making by using apps for tracking health information (OR 3.930, 95% CI 1.627-9.492); and between being a female and communication and consultation by closed conversation with a few acquaintances using ICT (OR 2.883, 95% CI 1.335-6.227).

Conclusions: This study implies immigration-related factors may confound associations between general user factors and eHealth activities. Further studies are needed to explore the influence of immigration-related user factors for eHealth activities in other immigrant groups and countries.

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KEYWORDS

immigrants; type 2 diabetes; self-care; information-seeking behavior; literacy; language

Introduction

Chronic Diseases and eHealth Use for Self-Care Among Immigrant Populations

Immigration surge made many European nations linguistically and culturally more diverse than ever, which poses a challenge to the health systems [1]. Immigrant populations are more likely to have challenges related to health care access due to language barriers and cultural differences [2-9]. Belonging to an ethnic minority as well as having low literacy in the official language of the host country are shown to be associated with poor health [10,11]. Furthermore, many immigrant groups have a lifelong exposure to low socioeconomic position [12], which leaves them at high risk of chronic diseases [13]. Different studies show that immigrant populations are often disproportionately affected by chronic diseases, such as type 2 diabetes mellitus (T2DM) [7,14-17]. The World Health Organization Regional Office for Europe recognized the importance to address these challenges, and advocated in its health policy framework “Health 2020” [18] that eHealth should be successfully implemented and utilized to reduce social health inequalities [19].

However, eHealth content is often text-based and designed for the nation’s majority population, thus enhancing social health inequalities rather than reducing them [11,20-24]. Designing eHealth services also aiming to include minority user populations requires sensitivity to their language and cultural preferences [25]. For immigrant populations, recent studies show less extended use of eHealth for specific purposes within self-care than among host populations [26-31]. However, knowledge is limited and mainly from the United States regarding the association between eHealth use and user factors that are especially relevant to immigrants, such as language proficiency [28,30,32,33] or the length of residence in the host country [34]. Both measures are frequently examined in relation to immigrants’ health behavior, health status, and access to and utilization of health care services [4,5,35-42]. Given that eHealth use can be considered a part of health behavior and use of available health care resources, the association between eHealth use for self-care and host language proficiency versus proficiency in their primary language or length of residence would be worth investigating.

In this paper, we discuss how this can be done in an explorative study identifying variations in the use of eHealth for self-care of T2DM among first-generation immigrants from Pakistan in

the Oslo area, Norway. Self-care is defined by the World Health Organization as “keeping health, prevention of and dealing with illness” [43]. Therefore, we target not only those who are given diagnoses of T2DM but also those who are engaged with the prevention of T2DM.

Pakistani Immigrants in Norway

At the beginning of 2018, first-generation immigrants comprised 14.1% of the whole population of Norway [44]. Pakistanis are one of the biggest immigrant groups from non-Western countries. The first Pakistani immigrants arrived in Norway in the 1970s. Steadily, new immigrants are coming from Pakistan for family reunification or establishment of a new family with Pakistani immigrants or their descendants in Norway [45]. The majority of this population concentrates in the Oslo area [46]. The completed level of education among the first-generation Pakistani immigrants in Norway varies widely [47].

The primary language of this population is Urdu. The Urdu language is written in the Urdu alphabet, which is unlike the Roman alphabet [48]. To our best knowledge, there is no statistic regarding Urdu literacy level of first-generation immigrants from Pakistan in Norway. However, data from United Nations Educational, Scientific and Cultural Organization shows the literacy rate in Pakistan among the population aged 15 years and older was 57% in 2014, and there was a considerable gap between males (69%) and females (44%) [49]. Thus, a nonnegligible number of first-generation Pakistani immigrants who migrated to Norway after school age, especially women, may also have a limited literacy level in the Urdu alphabet despite speaking fluently. In addition, our target population often use Roman Urdu—the Roman alphabet used to express Urdu pronunciation [50]. Roman Urdu is especially useful when typing text by a QWERTY keyboard on an information and communication technology (ICT) device.

Norwegian is the official and dominant language in Norway. According to a survey among first-generation immigrants with different countries of origin by Statistics Norway in 2016, 55% of the Pakistani participants self-reported high or very high Norwegian literacy level, whereas only 12% reported low or very low Norwegian literacy level [51]. However, the same survey shows that the immigrants who came at a later stage of life (after age of 17) are less likely to self-report a high or very high Norwegian literacy level (42%) than those who came to Norway at an earlier stage (age at immigration 0-6 years: 97%; 7-16 years: 89%) [51].

Data are not found regarding proficiency in other languages among the population. However, given that English is the most used language for eHealth content globally, those with English proficiency may use eHealth for T2DM self-care to a larger extent than those without English proficiency.

It has been demonstrated that the prevalence of diabetes is considerably higher among Norwegian-Pakistanis (women: 26.4%; men: 20.0%) than among their ethnic Norwegian counterparts (women: 2.7%; men: 6.4%) [14]. The reasons for the high diabetes risk are interrelated factors including both epigenetics and lifestyle; most of the diagnosis cases are T2DM [52]. Many experience significant changes in lifestyle when moving to Norway, including dietary changes [53]. Pakistani immigrants with diabetes have reported advice from Norwegian health care workers to be inadequate and difficult to comply with due to cultural differences [54].

Objectives

In this exploratory study, we examine how the immigration-related user factors specific to this target group are associated with their diverse eHealth use for T2DM self-care compared with general user factors that are typically used in similar studies, such as age, gender, education, digital skills, or general health status.

Relevant immigration-related user factors to this target group include proficiency in the relevant languages (literacy in Urdu as their primary language; proficiency in Norwegian as the host language; having proficiency in other languages, such as English, because it is the most common language used for eHealth content globally), length of residence in Norway, and diagnosis of T2DM. In this paper, we refer to them as “target group-specific user factors.”

Methods

Description of Survey

This study is part of a larger survey carried out among first-generation Pakistani immigrants in the Oslo area (N=176) in 2015-2016 [50] to explore the use of eHealth in this population. The informants were recruited by purposive sampling with a multirecruitment strategy [55]. The inclusion criteria were (1) immigrated from Pakistan after the age of 18 years, (2) live in the Oslo area, (3) speak Urdu (the official language of Pakistan) as the primary language in their private life, (4) aged between 25 and 59 years, (5) have access to or interest in using ICT tools (PC, tablet, or smartphone) connected to the internet in daily life, and (6) motivated for and capable of activities for self-care of T2DM [50]. The first and third criteria reflect our intention to include those who are more likely than others to have language and cultural barriers to regular health services.

Ethical approval was given to the project protocol by Norwegian Social Science Data Services in June 2015 (project number: 43549). The details of the survey have been described elsewhere [55].

Variables

Independent Variables

The independent variables can be divided into two categories: target group-specific variables and general variables. The target group-specific variables included literacy in Urdu, language proficiency in Norwegian, proficiency in another language (for each language), length of residence in Norway, and diagnosis of T2DM. The general variables included gender, age, self-assessment of health status, and completed education (both in Pakistan and Norway) in the form of total number of years. We also included frequency of asking for help when using ICT as a measure of digital skills as a part of the general variables.

We chose to use self-reported language proficiency by following the convention of similar studies of immigrants' health [3,5,33,56-58]. Confidence in Urdu literacy and in the Norwegian language was assessed using a 5-point Likert scale. One of the survey's inclusion criteria was speaking Urdu as the primary language in daily life [50]. However, as described in the Introduction, a nonnegligible proportion of participants may not have high-level literacy in Urdu despite speaking in Urdu daily. Also, Roman Urdu is often used for using ICT in general. Thus, for Urdu literacy, we were interested in reading and writing skills in both Urdu alphabet and Roman Urdu. For Norwegian language proficiency, we asked about confidence level in speaking as well as writing and reading. As there was no presumption about our target populations' proficiency in other languages, the survey included a question asking informants to name any other languages that they had confidence in. Having proficiency in another specific language was based on each named language to this question (dichotomous variable).

The informants specified the length of their residence in Norway to one of the categories of 0 to 1 year, 1 to 5 years, 5 to 10 years, and more than 10 years. Using ranges of years rather than exact numbers follows the convention of similar studies [3-5,37,40,56].

Age was represented by a middle year of an age range because the survey used age range instead of actual age to avoid the risk that an informant could be identified by a combination of answers to survey questions.

Self-assessment of health status was obtained by a multiple-choice question ranging from poor=0 to excellent=5. The frequency of asking for help when using ICT was given by a multiple-choice question with alternatives ranging from never=0 to always=4. This question captured a lack of digital skills. Further details are described elsewhere [55].

Dependent Variables

We considered the same dependent variables that were used in our previous study [55]; dichotomous answers to nine questions asking usage of different types of eHealth for T2DM self-care in the last 12 months, and the total number of positive answers. Among the nine questions, three questions received few positive answers. The three questions were asking about having experience of the following: seeking relevant information with T2DM self-care by searching for software programs on PCs or mobile apps that could be used as a look-up tool (8/176, 4.5%),

communicating or consulting about T2DM on portals for peer-communication (9/176, 5.1%), and communicating or consulting about T2DM self-care by online consulting to experts in diabetes (1/176, 0.6%). With such few positive answers, reliable statistical analysis was not possible and we decided to do further analyses only for the rest of the dependent variables. First, for seeking T2DM-relevant information (1) by using search engines that require input of search terms or (2) on specific websites or by email subscriptions that can be navigated by only scrolling and clicking. Second, for communicating or consulting about T2DM self-care (1) by using ICT in general for closed conversation with a few specific acquaintances, such as voice, video, or text communication, or (2) via social networking service (SNS). Third, for active decision making on T2DM self-care by using Web or mobile apps (1) for tracking health information, such as diet, physical activity, weight, blood glucose level, and so on, or (2) to assess own health status with regard to T2DM [55].

Statistical Analyses

Logistic regressions were used to assess the relationship between each type of eHealth use with the independent variables described previously. For total eHealth usage, which was a count variable, we used Poisson regression.

To select the best regression models, all possible combinations of including and excluding independent variables were evaluated using the best-fit method in the statistical program R [59]. We used the Akaike information criterion (AIC) as the selection criterion between models [60]. The AIC awards models with a good fit to the data and at the same time punishes models that use many independent variables to avoid overfitting. Thus, the best model will have a trade-off between the fit to the data and the number of variables included in the model.

Our previous study revealed that the scores for the questions “total years of education in Pakistan and Norway” and “frequency for asking for help when using ICT” were strongly correlated [55]. Therefore, we defined the variable “education and digital skills” as the mean score of these two questions. Before computing the mean, the following two steps were taken. First, to take into account that they were on different scales, the scores of the variables were standardized. Further, the scores

of the frequency of asking for help when using ICT were multiplied by -1 because higher knowledge results in less frequency of asking. The internal consistency of the scores for these two questions, using the standardized Cronbach alpha [61], was .70.

The questions about reading and writing in Roman Urdu and Urdu alphabet all reflect Urdu literacy. The internal consistency of the scores for these four questions, using the standardized Cronbach alpha, was .85. Therefore, we defined the “Urdu literacy” variable as the mean of these variables. Scores for the questions about reading, writing, and speaking the Norwegian language also showed a high internal consistency (Cronbach alpha=.92). Therefore, we also defined the “Norwegian language proficiency” variable as the mean of the three variables.

To reduce the number of variables to estimate in the statistical model and take into account that time is a continuous variable, the categorical variables for the length of residence (0-1 year, 1-5 years, 5-10 years, and more than 10 years) were transformed to a continuous variable by setting each of the variables to 0.5, 3, 7.5, and 15 years, respectively. If one immigrates at the age of 18 years or older, it is reasonable to expect that the effect of the length of residence tails off with time (eg, one learns more about the Norwegian society the first year after arrival compared to after the tenth year). Therefore, in addition to using the length of residence directly in the regression models, we also evaluated two transformations: the square root and the logarithm of the length of residence. By comparing the resulting models based on the AIC, the logarithm transform resulted in the best models and was used in the analyses.

A total of seven models were used to draw conclusions. To address the multiple testing problem, a Bonferroni-corrected significance value of $0.05/7=0.00714$ was used in this paper.

Results

Characteristics of the Sample

The distribution of the informants by the data concerning the general variables and the dependent variables has been described elsewhere [55] and is reproduced in Table 1.

Table 1. Descriptive characteristics of the survey informants (N=176).^a

Variables	Informants, n (%)
Demographic variables	
Gender	
Male	42 (23.9)
Female	134 (76.1)
Age group by birth year range	
1981-1990	54 (30.7)
1971-1980	61 (34.7)
1956-1970	61 (34.7)
Total years of education from Pakistan and Norway	
0 years	14 (8.0)
5 years	13 (7.4)
<10 years	17 (9.7)
<12 years	33 (18.8)
<14 years	39 (22.2)
≥14 years	55 (31.3)
Self-assessment of health status (score)	
Excellent (5)	11 (6.3)
Very good (4)	27 (15.3)
Good (3)	70 (39.8)
Fair (2)	37 (21.0)
Going up and down (1)	19 (10.8)
Poor (0)	12 (6.8)
Frequency of asking for help when using ICT^b	
Always (4)	18 (10.2)
Often (3)	26 (14.8)
Sometimes (2)	51 (29.0)
Seldom (1)	12 (6.8)
Never (0)	68 (38.6)
Experience of eHealth use for T2DM^c self-care in the last 12 months	
For seeking relevant information	
By using search engines that require input of search terms	35 (19.9)
On specific Web sites or by email subscriptions that can be navigated by only scrolling and clicking	63 (35.8)
For communication and consulting	
By using ICT in general for closed conversation with a few specific acquaintances	84 (47.7)
By social networking service	58 (33.0)
For active decision making on self-care by using Web apps or apps for:	
Keeping track of health information	25 (14.2)
Self-assessment of health status	38 (21.6)
Total number (variety) of eHealth types experienced	
≥8	0 (0.0)
7	2 (1.1)

Variables	Informants, n (%)
6	5 (2.8)
5	7 (4.0)
4	9 (5.1)
3	28 (15.9)
2	38 (21.6)
1	46 (26.1)
0	41 (23.3)

^aThis is a reproduction of Table 4 in our previous study [56]. There are modifications of labeling of the experience of eHealth use for T2DM self-care in the last 12 months as well as the omission of data not relevant to this paper.

^bICT: information and communication technology.

^cT2DM: type 2 diabetes mellitus.

Table 2 shows the distribution of the informants by the survey data related to language, length of residence, and diagnosis of T2DM. A vast majority of the informants showed confidence in reading (162/176, 92.0% for a total of “strongly agree” and “agree”) and writing (152/176, 86.3%) in Urdu alphabet. The proportions of informants with confidence in reading (123/176, 69.9%) and writing (116/176, 65.9%) in Roman Urdu were smaller than for Urdu alphabet. Not a negligible number of informants expressed lack of confidence in reading (7/176, 3.9% for a total of “strongly disagree” and “disagree”) and writing (13/176, 7.4%) the Urdu alphabet. The proportions of the sample lacking confidence in reading (26/176, 14.8%) and writing (33/176, 18.7%) in Roman Urdu were even higher. The Urdu literacy score was mean 4.26 (SD 1.26).

Regarding confidence level in the Norwegian language, the numbers concentrate around “neither” or “agree” in all three skills. The Norwegian language proficiency score was mean 3.35 (SD 1.08).

In total, 91 informants (51.7%) named English as another language they had confidence in. Arabic and Punjabi were named by two informants each, which is too small of a number to be applied in the statistical analyses. Therefore, we interpreted the answer “English” as “having English proficiency” in the further statistical analysis.

The majority of the sample (123/176, 69.9%) had lived in Norway for more than 10 years. The sample included only one informant (0.6%) who had lived in Norway for less than a year. A total of 27 informants (15.3%) answered that they had been diagnosed with T2DM.

Association Between User Factors and eHealth Use

Table 3 shows the Pearson correlation coefficients between the different variables. The highest correlation coefficient was .78 between Urdu literacy and education and digital skills ($P < .001$).

Table 2. Descriptive characteristics of the survey informants regarding target group-specific user factors (N=176).

User factors	Informants, n (%)
Urdu literacy “I am very confident in”:	
Reading Urdu alphabet	
Strongly agree (5)	147 (83.5)
Agree (4)	15 (8.5)
Neither (3)	7 (4.0)
Disagree (2)	2 (1.1)
Strongly disagree (1)	5 (2.8)
Writing Urdu alphabet	
Strongly agree (5)	137 (77.8)
Agree (4)	15 (8.5)
Neither (3)	11 (6.3)
Disagree (2)	3 (1.7)
Strongly disagree (1)	10 (5.7)
Reading Roman Urdu	
Strongly agree (5)	95 (54.0)
Agree (4)	28 (15.9)
Neither (3)	27 (15.3)
Disagree (2)	6 (3.4)
Strongly disagree (1)	20 (11.4)
Writing Roman Urdu	
Strongly agree (5)	94 (53.4)
Agree (4)	22 (12.5)
Neither (3)	27 (15.3)
Disagree (2)	9 (5.1)
Strongly disagree (1)	24 (13.6)
Norwegian language proficiency “I am very confident in”:	
Reading Norwegian	
Strongly agree (5)	26 (14.8)
Agree (4)	71 (40.3)
Neither (3)	46 (26.1)
Disagree (2)	24 (13.6)
Strongly disagree (1)	9 (5.1)
Writing Norwegian	
Strongly agree (5)	22 (12.5)
Agree (4)	53 (30.1)
Neither (3)	53 (30.1)
Disagree (2)	33 (18.8)
Strongly disagree (1)	15 (8.5)
Speaking Norwegian	
Strongly agree (5)	28 (15.9)
Agree (4)	49 (27.8)
Neither (3)	73 (41.5)

User factors	Informants, n (%)
Disagree (2)	18 (10.2)
Strongly disagree (1)	8 (4.5)
Any other language an informant is confident in	
English	91 (51.7)
Punjabi	2 (1.1)
Arabic	2 (1.1)
Length of residence in Norway	
0-1 year	1 (0.6)
1-5 years	20 (11.4)
5-10 years	32 (18.2)
More than 10 years	123 (69.9)
Type 2 diabetes mellitus	27 (15.3)

Table 3. Correlation coefficients between the independent variables for the statistical analyses and *P* values.

Variable	1	2	3	4	5	6	7	8	9
1. Being a female	— ^a								
2. Age	-.04								
3. Self-assessment of health status	-.23 ^b	-.32 ^c							
4. Norwegian language proficiency	-.25 ^b	-.06	.22 ^b						
5. Type 2 diabetes	-.02	.32 ^c	-.33 ^c	-.16 ^d					
6. English proficiency	-.25 ^b	-.29 ^c	.22 ^b	.50 ^c	-.19 ^d				
7. Education and digital skills	-.31 ^c	-.37 ^c	.43 ^c	.54 ^c	-.26 ^c	.55 ^c			
8. Urdu literacy	-.22 ^b	-.34 ^c	.38 ^c	.51 ^c	-.28 ^c	.53 ^c	.78 ^c		
9. Logarithm of years of residence in Norway	.09	.59 ^c	-.31 ^c	.16 ^d	.20 ^b	-.18 ^d	-.29 ^c	-.21 ^b	—

^aNot applicable.

^b*P*<.01.

^c*P*<.001.

^d*P*<.05.

Table 4 shows the estimates of six multiple logistic regression models. The table shows results for the best regression model (based on best fit) for each dependent variable. To interpret the table, for example, “for seeking relevant information by using search engines that require the input of search terms” represents the dependent variable for the first regression analyses and the next three rows show the independent variables for this model. Note that estimates in the logistic regression analysis are the logarithm of the odds ratio, but we transformed them to odds ratios in Table 4 to make it easier to interpret. Table 5 shows the results of the Poisson regression analysis. Again, the best regression model is shown.

In the models in which language-relevant variables remained, Urdu literacy and Norwegian language proficiency were positively related to use of different types of eHealth for T2DM self-care. Urdu literacy was positively associated with the following: seeking relevant information to T2DM self-care on specific websites or by email subscriptions, communication and

consulting about T2DM self-care by SNS, and with the total number of eHealth types experienced. Norwegian language proficiency was positively related to use of Web or mobile apps for self-assessment of health. Having English proficiency was neither positively nor negatively related to any dependent variable.

Regarding years of residence in Norway, the logarithm of this value was positively associated with communication and consulting about T2DM self-care by using ICT for a closed conversation with a few specific acquaintances, and by SNS, as well as with the total number of eHealth types experienced. Having been diagnosed with T2DM was not related to any dependent variable.

The composite variable education and digital skills appeared positively associated with the use of Web or mobile apps for keeping track of health information. Being a female was positively associated with using ICT for closed communication

and consultation about T2DM self-care with a few specific acquaintances. Age had no significant association with any dependent variable. Self-assessment of health status did not remain in any model.

Table 4. Logistic regression analysis of the association between eHealth use and user factors.

Dependent and independent variables	Odds ratio (95% CI)	<i>P</i> value ^a
For seeking relevant information		
By using search engines that require the input of search terms		
Intercept	0.022 (0.002-0.209)	.001
T2DM ^b	3.576 (1.301-9.832)	.01
Urdu literacy	1.649 (1.026-2.651)	.04
On specific Web sites or by email subscriptions that can be navigated by only scrolling and clicking		
Intercept	0.019 (0.002-0.144)	<.001
Urdu literacy	2.155 (1.388-3.344)	.001
Logarithm of years of residence in Norway	1.371 (0.966-1.947)	.08
For communication and consulting		
By using information and communication technology in general for a closed conversation with a few specific acquaintances		
Intercept	0.396 (0.199-0.788)	.008
Being a female	2.883 (1.335-6.227)	.007
Logarithm of years of residence in Norway	1.728 (1.193-2.503)	.004
By social networking service		
Intercept	0.002 (0-0.207)	.008
Age	0.951 (0.903-1.001)	.06
Having English proficiency	0.379 (0.166-0.863)	.02
Urdu literacy	5.697 (2.487-13.053)	<.001
Logarithm of years of residence in Norway	2.098 (1.265-3.480)	.004
For active decision making on T2DM self-care by using Web or mobile apps for		
Keeping track of health information		
Intercept	4.253 (0.256-70.507)	.31
Age	0.909 (0.844-0.979)	.01
Education and digital skills	3.930 (1.627-9.492)	.002
Logarithm of years of residence in Norway	1.753 (0.983-3.127)	.06
Self-assessment of health		
Intercept	0.263 (0.023-2.951)	.28
Age	0.935 (0.887-0.985)	.01
Norwegian language proficiency	2.285 (1.294-4.036)	.004
Having English proficiency	0.418 (0.154-1.139)	.09
Education and digital skills	2.414 (1.104-5.28)	.03

^aA Bonferroni-corrected significance value of 0.00714 was used to interpret the *P* values.

^bT2DM: type 2 diabetes mellitus.

Table 5. Poisson regression analysis of the association between the variety of experienced eHealth activities and user factors.

Total number (variety) of eHealth types experienced	Estimate (95% CI)	<i>P</i> value ^a
Intercept	-0.158 (-1.321, 1.005)	.79
Age	-0.019 (-0.035, -0.003)	.02
T2DM ^b	0.310 (-0.012, 0.633)	.06
Having English proficiency	-0.209 (-0.462, 0.044)	.11
Education and digital skills	0.181 (-0.037, 0.399)	.10
Urdu literacy	0.350 (0.148, 0.552)	.001
Logarithm of years of residence in Norway	0.270 (0.117, 0.424)	.001

^aA Bonferroni-corrected significance value of 0.00714 was used to interpret the *P* values.

^bT2DM: type 2 diabetes mellitus.

Discussion

Principal Findings and Implications for Future Studies

This study explored diverse eHealth use for T2DM self-care by first-generation immigrants from Pakistan in the Oslo area in relation to two types of user factors: (1) target group-specific user factors including proficiency in relevant languages, length of residence in the host country, and a diagnosis of T2DM, and (2) general user factors including education level, age, gender, self-assessment of health status, and digital skills. The results of multiple regression analyses showed that in all the final models at least one of the target group-specific variables remained. In addition, in most models target group-specific variables were most strongly associated with eHealth use. Therefore, in our survey sample, the inclusion of target group-specific user factors yielded better-fitting models predicting use of eHealth for different purposes compared with only including general user factors.

Informants with higher Urdu literacy were more likely than those with lower Urdu literacy to seek relevant information on Web portals or obtain such information by email subscriptions, to use SNS for communication and consulting about T2DM self-care, and to use a wider variety of eHealth services. For these types of eHealth use, Norwegian language proficiency did not remain in the final models. Use of mother tongue as the first choice for seeking information of interest is probably a natural behavior, as long as users expect or know that they can reach the information they need. SNS is often used for keeping online connection and communication with people one already knows. Therefore, it is also reasonable to speculate that informants communicate by SNS with their Pakistani family, friends, or alike who share an interest in T2DM self-care.

Norwegian language proficiency was positively associated with only use of Web or mobile apps for self-assessment of health as a part of T2DM self-care. It is reasonable to speculate that informants who are fluent in Norwegian have a better chance to know and use such services provided in the Norwegian language and that Norwegian eHealth services are of value for this subgroup of immigrants. The result leaves a question about why Urdu language literacy was not associated with the use of these eHealth services. Implications here could be either that such services are unavailable in Urdu language or that the

informants were unaware of them despite their availability. Thus, it will be worth further examining if the informants have ever tried to search the internet for or been aware of such services offered in the Urdu language. Given the results that Norwegian language proficiency and Urdu literacy were associated with different types of eHealth activities, it would also be worth further investigating the difference in information or advice they receive from the different channels as well as the difference in user experiences. Another interesting question to pursue in future studies would be if the use of this type of eHealth service provided in the Norwegian language can positively affect the overall social integration in the Norwegian society for minority populations and vice versa, as well as health behavior.

Approximately half of the sample answered they are also confident in English. Nevertheless, English proficiency was not associated with any type of eHealth use for T2DM self-care. It is difficult to speculate the reason for irrelevance between having English proficiency and eHealth use for T2DM self-care among the sample. However, the implication here is that the target population may not use eHealth content in English for T2DM self-care as much as those in the Norwegian or Urdu language. As described in the Introduction, there are only a limited number of studies available that have investigated the relevance between immigrant populations' eHealth use and language proficiency or similar [28,30,32,33]. All these studies are from the United States, where English is the primary language. Because of this, as well as differences in study design, our results cannot be simply compared with these studies. However, most of the studied cases found having English proficiency or similar user factors to be associated with eHealth use or confidence regarding eHealth use [28,30,32,33]. The results call for the need for more knowledge by studying other immigrant groups in European countries where English is not the primary language of either the immigrant groups or the host country.

In its logarithm form, years of residence in Norway was positively associated with closed communication with a few acquaintances and use of SNS, as well as the total number of eHealth types experienced in the last 12 months. An interpretation here could be that the longer immigrants live in Norway, the more people they connect with who also are at high risk of, or having, T2DM. Further, they may be more

exposed to eHealth possibilities than those with shorter length of residence in Norway, although such effect may not be linear given the relatively short history of eHealth and needs to be seen by controlling the age of users. Other studies about immigrants' use of eHealth in the United States showed that the effect of length of residence on eHealth use is not monotonically increasing; the group in the middle segment showed the highest eHealth engagement compared with those who lived in the host country the shortest or the longest [30,34]. These studies in the United States cannot be simply compared with our study because they include immigrants regardless of age at immigration, whereas all the informants in this study immigrated to Norway after the age of 18. Also, the types of eHealth activity they explore are not exactly the same as this study. Nevertheless, given the natural relevance between age and years of residence, future studies with larger sample sizes should further explore the relation between these factors by, for example, segmenting the sample and comparing the subgroups with different lengths of residence.

Despite remaining in the final model of using search engines to seek relevant information on T2DM self-care and the variety of eHealth activities experienced, having a diagnosis with T2DM was not significantly associated with any type of eHealth activity. One of the inclusion criteria of the survey was "being motivated for and capable of performing activities for self-care of T2DM"; thus, having a diagnosis of T2DM in itself may not be relevant enough to differentiate users and nonusers of eHealth for self-care of T2DM among the survey sample. Self-assessment of health did not remain in any model. Being in good condition could be a consequence of—and being in bad condition could be the motivation for—using eHealth for self-care. Thus, self-assessment of health at the time of participation in a survey may not be a good indicator of eHealth use for T2DM self-care.

Implications for Development and Dissemination of Future eHealth Services to Reduce Social Health Inequalities

The results present valuable insight about relevant user factors of diverse eHealth activities for T2DM self-care among one of the little-studied, vulnerable user groups. The yielded knowledge can be used to guide further research on designing, developing, and disseminating eHealth tools for this vulnerable population to achieve the goal to reduce social health inequalities.

Despite an inclusion criterion of being "motivated for and capable of activities for self-care of T2DM," not all types of eHealth activities were common enough among the sample. The findings of this study indicate that there is a certain divide among the target population regarding eHealth activities. First, those with high Norwegian language proficiency, and those with high education and digital skills, are more likely to use apps for self-assessment of health and to keep track of health information by using apps, respectively. Second, those with high Urdu literacy were more likely to go online for relevant information seeking and communication via SNS in connection with T2DM self-care than those with low Urdu literacy. In addition, nearly half of the sample had used ICT for closed conversation with specific acquaintances for consulting about

T2DM, which is strongly associated with the longer period of residence in Norway. The implication here could be the importance of disseminating reliable health information or self-care apps through their social network. Relevant studies on eHealth use by immigrant populations also support use of the target populations networks [34] as well as stakeholders to promote available eHealth services [30,62].

On the other hand, translation into English seems not to be equally relevant, as having English proficiency was found to have no association with eHealth use for this population despite that more than half the sample showed confidence in English. Hence, to reduce social inequalities through eHealth services, these need to be offered both in Norwegian and minority languages that are especially relevant to high-risk groups of social health inequalities. The importance of provisioning easy-to-read, culturally appropriate health information in their own language is also outlined in relevant studies [28,30,32]. The quality and amount of information in eHealth content provided in the nondominant language should not be deteriorated because such a problem is reported in relevant studies [63,64]. Immigrants are heterogeneous in terms of linguistic and cultural background. Provision of eHealth services in many minority languages that are adapted to the cultural background would be highly demanding and costly. Machine translation seems not to have reached a level of sufficient accuracy, but it could be useful when used in combination with human translation [65,66]. Moreover, further development of machine translation technology has great potential to enable provision of eHealth services in minority languages at less cost and at a more trustable level than today.

Limitations

Limitations regarding the survey sample and the survey methods we reported in our previous study [55] apply to this study as well. In addition, we should note that this study may suffer from nonprobability sampling, albeit the multirecruitment method we took was more appropriate for recruiting the target population than ordinary probability sampling [67].

For this particular study, we should note the following. Data about English proficiency was obtained in an indirect manner by asking about any language that the informants were confident in. This method may have caused underestimation of the number of informants with high confidence in English proficiency to some extent but should not have caused overestimation. Given the results of the regression analyses, even if the number of informants with high English proficiency increases to some degree, the results would not change drastically.

Our study relates to one specific population in one specific context. We invite future research to explore if these findings could be replicated in other contexts and populations and explore potential generalizability of the results.

Conclusion

The contribution of this study is advancing knowledge on user factors associated with diverse eHealth activities among one of the immigrant populations in European countries, which is a vulnerable and little-known user group. Particularly, this study showed the importance of examining the target group-specific

user factors for their associations with experience of diverse eHealth activities when the target group is a vulnerable immigrant population. This study also implied that to facilitate and enhance eHealth use by immigrant populations, eHealth services should be provided in minority languages rather than

using English as a common language for foreigners. Future studies are needed for a further understanding of other target user groups vulnerable to poor health or low socioeconomic position due to the same or similar reasons as our sample.

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Authors' Contributions

NT and HLH conceived this study. NT drafted the study design and the first version of the manuscript. HLH designed and conducted the statistical analyses and wrote the draft of the relevant part. The other three authors contributed to further development of the study design and to finalizing the manuscript by giving comments to all versions of the manuscript draft. All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

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Abbreviations

- AIC:** Akaike information criterion
ICT: information and communication technology
OR: odds ratio
SNS: social network service
T2DM: type 2 diabetes mellitus

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Original Paper

Flucast: A Real-Time Tool to Predict Severity of an Influenza Season

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Abstract

Background: Influenza causes serious illness requiring annual health system surge capacity, yet annual seasonal variation makes it difficult to forecast and plan for the severity of an upcoming season. Research shows that hospital and health system stakeholders indicate a preference for forecasting tools that are easy to use and understand to assist with surge capacity planning for influenza.

Objective: This study aimed to develop a simple risk prediction tool, Flucast, to predict the severity of an emerging influenza season.

Methods: Study data were obtained from the National Notifiable Diseases Surveillance System and Australian Influenza Surveillance Reports from the Department of Health, Australia. We tested Flucast using retrospective seasonal data for 11 Australian influenza seasons. We compared five different models using parameters known early in the season that may be associated with the severity of the season. To calibrate the tool, the resulting estimates of seasonal severity were validated against independent reports of influenza-attributable morbidity and mortality. The model with the highest predictive accuracy against retrospective seasonal activity was chosen as a best-fit model to develop the Flucast tool. The tool was prospectively tested against the 2018 and the emerging 2019 influenza season.

Results: The Flucast tool predicted the severity of all retrospectively studied years correctly for influenza seasonal activity in Australia. With the use of real-time data, the tool provided a reasonable early prediction of a low to moderate season for the 2018 and severe seasonal activity for the upcoming 2019 season. The tool meets stakeholder preferences for simplicity and ease of use to assist with surge capacity planning.

Conclusions: The Flucast tool may be useful to inform future health system influenza preparedness planning, surge capacity, and intervention programs in real time, and can be adapted for different settings and geographic locations.

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KEYWORDS

prediction tool; influenza; risk assessment

Introduction

Influenza is an epidemic infection that affects millions of people around the world with varying severity. It infects approximately 10% to 15% of adults and 20% to 30% of children annually [1].

In aged care facilities and within the community, estimated attack rates can be 25% or higher [2,3].

Traditionally, influenza activity is monitored through a range of national and global surveillance networks in each country and globally. The data sources include laboratories, hospitals

and sentinel general practices, morbidity and mortality data from health departments, and online self-reported community surveillance such as Flu Tracking [4-7]. These data, however, are typically retrospective and have inherent time lags. They are not generally used to forecast the severity of an emerging season and may not provide early warning for facilitating preparedness and surge capacity planning. Increased hospital and health system demand during the influenza season [8-10] is a high priority for health managers because influenza epidemics result in a surge of emergency department and hospital admissions [11-13].

Various predictive tools and methods for forecasting influenza epidemics and timing of seasonal peaks for influenza have been developed [14-16]. The Centers for Disease Control and Prevention (CDC) and other institutions in the United States have developed influenza assessment tools that are made available for local-level seasonal prediction [17]. In 2016, the CDC launched FluSight on the Epidemic Prediction Initiative website to forecast weekly influenza activity [18]. Research teams submit weekly flu forecasts to FluSight, which then provides information on influenza onset week, peak week, and peak intensity as well as influenza-like illness activity during the season [19].

Using the CDC FluAid 2.0 modeling tool [17], one Australian study reported a favorable forecasting value for decision making and planning of health care services during the 2009 influenza pandemic [20]. The study found that the model predictions were comparable to actual reports from hospitals regarding hospital and intensive care admissions in the study. It was evident that timely use of modeling tools could help to inform and manage resources and surge capacity requirements at hospitals during severe seasons and pandemics [20]. Although these advanced modeling tools are useful to forecast the situation in real time, they involve complex mathematical modeling approaches that are not easily understood by health system stakeholders and may not be adaptable to other settings.

From a previous study of Australian epidemic planning and preparedness, we found that stakeholders do not apply epidemic modeling tools in routine public health practice, and they have skepticism and distrust of modeling tools. They indicated a preference for simple tools, which are easy to apply and understand. In addition, the stakeholders stated that their highest priority was surge and workforce capacity planning during the influenza season [21].

To forecast the influenza epidemic in real time and assist with surge capacity planning, we aimed to develop a simple assessment tool for early prediction of seasonal influenza severity using the surveillance data in the study.

Methods

Overview

The Australian influenza season generally falls between May and October, with the peak occurring between July and September [22]. Laboratory-confirmed influenza infection is a notifiable disease in Australia, and cases are reported to state and territory health authorities. National data are published by

the Australian Government Department of Health. During the influenza season, the Australian Influenza Surveillance Reports provide biweekly descriptive reports of influenza activity at a national level, including updates on international influenza activity [7]. In this study, a tool was developed by fitting an algorithm to 11 years of retrospective influenza data and then testing it prospectively against the 2018 and the emerging 2019 influenza season in Australia.

Data Sources and Parameters

Data were obtained from the following sources: (1) laboratory-confirmed influenza notifications from the National Notifiable Diseases Surveillance System (NNDSS) [5] and (2) published Australian Influenza Surveillance Reports [7] in 2016 and 2017. The National Australian Influenza Surveillance Scheme, the Australian Government, Department of Health reports and provides information regarding seasonal influenza activity, circulating viruses, and influenza vaccine information for the years studied.

When developing the models, a range of variables was considered to include in the forecast model to predict the severity of seasonal activity. These included total number of notified cases in the season using a different month (such as April, May, or June) to determine early or late season starts as well as the magnitude, viral subtypes in circulation, pediatric influenza-related deaths, reported number of influenza-related hospitalizations, intensive care admissions at a single time point, and reported influenza-associated deaths in the season. However, in early testing of more than nine variations with inclusion and exclusion of the different variables mentioned previously in models with at least three to six parameters (data not shown), several of these variables and models were excluded in the forecast model because they did not contribute to or assist in predicting seasonal influenza severity. We then selected the parameters that were associated with or contributed to the severity of influenza during the season, such as timing of season, magnitude or number of notified cases, viral strain, and influenza-associated hospitalizations or deaths in the season. In the final selections, we selected five parameters and five different models that might contribute to or assist in predicting the season's severity to test the best-fit model for the tool. The data applied were for the Australian influenza season in the study; therefore, month 1 was defined as May (the first month of the beginning of influenza season) and month 2 as June in the models. The five parameters considered are discussed subsequently.

Timing of Seasonal Onset

This was used to define the onset of a season (being an early or late onset to see any impact on seasonal severity) using notifications in month 1 or month 2 for a given year. For this parameter, data were retrieved from the NNDSS [5].

Relative Magnitude of Influenza Activity

The relative magnitude was the relative rate of influenza notifications in month 1 or month 2 compared with the past five years' average. Data were obtained from the NNDSS [5].

Dominant Strain in Circulation

This was defined as the viral strain that was 50% or more of the circulating strains or the highest proportion strain circulating during the season. Severity and scoring criteria were assigned based on reported studies [10,23,24]. Data were obtained from the Australian Influenza Surveillance Report from the Department of Health [7]. A novel strain (categorized as the most severe strain) and A(H1N1)pdm09 in 2009 were treated as a novel or pandemic strain for that year, followed by influenza A(H3N2), influenza B, and influenza A(H1N1). Due to the inclusion of pre-pandemic years (2007 and 2008), the influenza A(H1N1) subtype was included in the study, although it has not been circulated widely since 2009.

Vaccine Mismatch

A documented mismatch of a vaccine strain is a change in the amino acid in the hemagglutinin or neuraminidase surface proteins of dominant strains of influenza viruses in circulation and the southern hemisphere influenza vaccine strains recommended by the World Health Organization (WHO) for a given season. Reports of a vaccine mismatch were retrieved from the Australian Influenza Surveillance Report-WHO Collaborating Centre for Reference and Research on Influenza [7]. The vaccine mismatch information is available at the earliest around month 1 (May) or month 2 (June) if there is delayed reporting during the season.

Early Season Deaths

Data on early season deaths (rate of notified influenza-associated deaths early in the season per 100,000 population) were obtained from the report of influenza-associated deaths notified to the NNDSS at the end of July in the current influenza season from the Australian Influenza Surveillance Report [7]. Data from July were used to account for delayed reporting of deaths in the administrative system in general. Population data were obtained from the Australian Bureau of Statistics from the Australian Government [25]. Morbidity and mortality burden could demonstrate the severity of influenza infection; thus, we applied mortality (deaths data) to predict seasonal severity in the models.

Severity prediction of influenza is complex and multifocal in nature, and more than one factor would have been attributed to the severity in the season. In our models, we assumed that each parameter contributed equally to the prediction of seasonal severity. Each model contained either four or five parameters as listed in Table 1. Model 1 was chosen as a reference model, and the other models (models 2-5) resulted from the removal or replacement of a parameter from the reference model (model 1).

The five models tested were:

1. Model 1: consisted of all five parameters (parameters 1-5 as shown in Table 1) and was used as a reference model in the study.
2. Model 2: consisted of four parameters (parameters 2-5), with removal of the seasonal onset column from the reference model.

3. Model 3: consisted of four parameters (parameters 1-4), with removal of notified influenza-associated deaths from the reference model.
4. Model 4: consisted of all five parameters (parameters 1-5) as in Model 1; however, a different scoring method was used to score the dominant strain in the model.
5. Model 5: consisted of all five parameters (parameters 1-5). In this model, for a designated month, month 2 was used instead of month 1 to calculate the ratio of notifications for both parameters 1 and 2 in the model.

Then, we considered predefined criteria to score parameters in the model. A simple, discrete linear scoring method, with 0 being the lowest and 4 being the highest score, was used to score each parameter (Table 1).

A score of 0 was regarded as no impact, and a higher score indicated a stronger prediction of severity for the season. For any given year, each parameter was given a score based on its value. The score increased with a higher risk value of the parameter. The scores for each parameter were summed to give a total score for each year in the model. The maximum possible score given in the model ranged from 16 to 20, depending on the number of parameters included in the model. For example, in model 1, the maximum possible score would be the sum of the highest score of 4 for each parameter multiplied by 5 parameters, which equals 20.

Scoring of Models and Selection of the Best-Fit Model

In developing the Flucast tool, data available each year from the influenza surveillance reports and laboratory-confirmed influenza notifications from the NNDSS were compiled to predict and categorize annual influenza seasonal severity in the models [5,7]. The historical data from the past 11 consecutive years (2007-2017 including the pandemic in 2009) were applied. We trained the model using data from 2007 to 2017 retrospectively and tested it with 2018 data in real time as the 2018 influenza season was emerging at the time of the study.

As per the scoring criteria in Table 1, data were scored and total scores were calculated for an individual year in the five models. Then, the severity index percentage was calculated for each year. The formula for calculating the severity index for any given year in the model was:

$$\text{severity index (\%)} = \left(\frac{\text{total score obtained from the parameters}}{\text{maximum score in the model}} \right) * 100$$

Lastly, we calibrated the severity index against seasonal severity (with reference to historical data from the surveillance reports, knowing which past seasons were mild, moderate, or severe in Australia). We considered the bottom 30% as mild, middle 30% as moderate, the next 30% as severe, and the final 10% as very severe, and severity index was categorized as a mild season (<30%), moderate (30% to 59%), severe (60% to 89%), or very severe season (≥90%). The severity index resulting from the model outputs were then applied accordingly to calibrate the seasonal severity.

Table 1. Parameters and scoring criteria of the influenza prediction models (Australian Influenza Surveillance Reports [7] and NNDSS [5]).

Parameter and criteria	Scores
1. Timing of seasonal onset: Ratio of laboratory-confirmed influenza notifications in month 1 to preceding four months' average for a given year [models 1, 3, & 4] or ratio of laboratory-confirmed influenza notifications in month 2 to preceding four months' average for a given year [model 5], if...	
≤1	0
>1 to 1.5	1
>1.5 to 2	2
>2 to 2.5	3
>2.5	4
2. Relative magnitude of influenza activity: Ratio of laboratory-confirmed influenza notifications in month 1 for a given year compared with last 5 years' average for the same period [models 1, 2, 3, & 4] or ratio of laboratory-confirmed influenza notifications in month 2 for a given year compared with last 5 years' average for the same period [model 5], if...	
≤1	0
>1 to 1.5	1
>1.5 to 2	2
>2 to 2.5	3
>2.5	4
3. Dominant strain in circulation: Viral strain comprising ≥50% of circulating strains or the highest proportion circulating in the season	
For scoring in models 1-3 and 5	
B or A(H1N1)	1
A(H1N1)pdm09	2
A(H3N2)	3
Novel strain	4
For scoring in model 4	
A(H1N1)	1
B	2
A(H3N2) or A(H1N1)pdm09	3
Novel strain	4
4. Vaccine mismatch in the season: Documented vaccine mismatch with the dominant strain in the season	
No mismatch	1
Mismatch in 1 strain only	2
Mismatch in >1 but not all strains	3
Mismatch in all strains	4
5. Early season deaths: Rate of notified influenza-associated deaths per 100,000 population at the end of July in the current season	
≤0.01	1
>0.01 to 0.05	2
>0.05 to 0.1	3
>0.1	4

From the five potential models, the model with the best fit against the known severity of the past 11 seasons was selected as the final model for the Flucast tool. Thus, the best-fit model would be the model that would give the highest accuracy of seasonal prediction among the five.

Independent data on morbidity and mortality were used to classify and validate the annual seasonal impact for the years

included as very severe, severe, moderate, or mild [5,26], which provided accuracy and classification for forecast severity. However, the results from a recent Australian study were available up to 2013 [26]; thus, the estimated seasonal impact for the years 2014 to 2017 were validated using records from the National Influenza Surveillance Reports [7]. In Australia, the years 2008, 2010, 2011, and 2013 to 2016 had moderate or mild seasonal activity; 2007, 2012, and 2017 were severe

seasons. In general, a pandemic can occur at any time point, and the 2009 pandemic year in Australia somehow coincided with the seasonal period, but only a few months earlier than the usual time in the country.

Using the final chosen model, we developed and implemented the online Flucast tool, which allows users to enter information obtained from the real-time surveillance data to predict the severity of the current influenza season. Input data required for parameters, the procedure for calculation, and links to the sources of Australian data are also provided on the webpage. Options to choose an answer for each parameter are provided in the drop-down lists. Once all answers are filled, a severity index percentage with estimated seasonal severity appears on the thermometer indicator as the final output of the tool. The Flucast tool online page is incorporated in a designated website, and the Web link to the online site is presented in the study.

The Flucast tool was developed and validated in 2016 and 2017 in Australia using the local data. A modified version of the Flucast tool has also been developed, which is adapted for other settings, such as countries in the southern or northern hemisphere with regular influenza seasonal patterns. For these

modified versions, we assumed that the influenza season falls between May and October for the southern hemisphere countries and November and April for countries in the northern hemisphere.

Results

Scoring of Models and Selection of the Best-Fit Model

Using the available Australian data for past influenza seasons and prospectively for the 2018 influenza season, all five models were scored using the scoring criteria and forecasted the seasonal severity for each year. An example of the scoring method is shown in Table 2 for model 1 (the reference model). Final scores for models 2 to 5 are presented in Multimedia Appendices 1-4.

The outputs from the five proposed alternative models provided a reasonable estimation of influenza severity. All models except model 3 predicted well for the severe seasons of 2007 and 2012, as well as 2017 in Australia. All five models identified the 2009 pandemic year as a very severe season. There were some variations across the models in predicting moderate and mild seasons.

Table 2. Scoring method for model 1 (from Australian Influenza Surveillance Reports [7] and NNDSS [5]).

Year	Actual impact of season	Parameters ^a					Total score (max=20)	Severity index ^b , %
		Timing of seasonal onset (score)	Relative magnitude of influenza activity (score)	Dominant strain (score)	Vaccine mismatch in the season (score)	Early season deaths (score)		
2007	Severe	1.1 (1)	1.3 (1)	A/H3N2 (3)	All strains (4)	18 ^c (3)	12	60
2008	Moderate	1.7 (2)	2.8 (4)	B (1)	1 strain (2)	3 ^c (1)	10	50
2009	Very severe (pandemic)	13.7 (4)	19.3 (4)	Novel/pandemic strain or A/H1N1pdm09 (4)	All strains (4)	61 (4)	20	100
2010	Mild	1.2 (1)	0.3 (0)	A/H1N1pdm09 (2)	None (1)	2 (1)	5	25
2011	Moderate	1.1 (1)	1.4 (1)	A/H1N1pdm09 (2)	None (1)	10 (2)	7	35
2012	Severe	2.5 (3)	1.4 (1)	A/H3N2 (3)	>1 but not all strains (3)	23 (3)	13	65
2013	Moderate	1.1 (1)	0.8 (0)	A/H1N1pdm09 (2)	1 strain (2)	11 (2)	7	35
2014	Moderate	1.1 (1)	1.2 (1)	A/H1N1pdm09 (2)	1 strain (2)	22 (3)	9	45
2015	Moderate	1.5 (1)	2.9 (4)	B (1)	None (1)	46 (4)	11	55
2016	Moderate	1.0 (0)	1.5 (1)	A/H1N1pdm09 (2)	None (1)	17 (3)	7	35
2017	Severe	1.3 (1)	2.1 (3)	A/H3N2 (3)	1 strain (2)	43 (4)	13	65
2018 ^d	Moderate	0.6 (0)	1.0 (0)	A/H1N1pdm09 (2)	None (1)	35 (3)	6	30

^aTiming of seasonal onset: ratio of laboratory-confirmed influenza notifications in May/January to April average [5]; relative magnitude of influenza activity: ratio of laboratory-confirmed influenza notifications in May compared to last 5 years' average [5]; dominant strain: dominant strain in circulation [7]; vaccine mismatch in season: vaccine mismatch with dominant strain(s) [7]; early season deaths: rate per 100,000 population of notified influenza-associated deaths at the end of July in the season [7].

^cSeverity index=total score/maximum score.

^dInfluenza-associated deaths in 2007 and 2008 were estimated by calculating the proportion (total number of notifications at the end of July/total notifications in the year) multiplied by total deaths reported by the Australian Bureau of Statistics for 2007 and 2008, accordingly.

^eProspective year, real-time data.

In our study, we used a simple method of scoring variables and parameters to estimate the severity of the influenza season. There were not many differences between the models; however,

it indicated that the removal of notified influenza-associated deaths (model 3) gave the lowest predicted accuracy among the five models. Model 1 estimated well for all seasons

retrospectively for the past 11 years and predicted the prospective 2018 season correctly when the results were validated against the actual impact of the influenza season in Australia. Thus, from the five tested models, model 1 showed the best fit for all years, accurate for 11 of 11 seasons, so it was chosen as the best-fit model for the Flucast tool. It was followed by model 2, then models 4, 5, and 3. The severity indexes and predicted seasonal activities by the models are described in [Table 3](#). In validating the impact of actual seasons with predicted estimates, the reported data may be underestimated [27]; however, these data did show a seasonal trend for the years studied. Using the Flucast tool for real-time assessment in 2018, the tool predicted the season as moderate (severity index score of 30%) by late July. The seasonal peak occurred in late August in 2018, and a low level of seasonal activity was reported for 2018 in general [28].

Sensitivity analysis of the Flucast tool was conducted as a post hoc analysis in the study. In predicting moderate versus mild seasons using fewer parameters (less than five parameters), the results were less accurate. The sensitivity was reduced to approximately 17% in predicting moderate seasons. Also, we

found that the models were 33% less sensitive in predicting a severe versus moderate season when using only four parameters (data not shown). As a result, we did not test further for mild seasons, and we concluded that the tool might not provide an accurate estimation of seasonal activity with fewer parameters. In addition, the impact of a pandemic year in the model prediction was also determined in the study. Sensitivity was tested in model 1 from 2010 to 2014 for scoring of parameter 2 in calculating the last 5 years' average with inclusion and exclusion of 2009 to see the overall impact on seasonal prediction by the model. It was shown that seasonal predictions were almost the same, except for 2010 (data not shown).

The online form of the Flucast tool and an example of the tool image (as predicted seasonal severity for 2019) is shown in [Figure 1](#) [29]. The Flucast tool was tested using real-time data for the 2019 emerging influenza season as data became available, and the tool predicted the upcoming season to be severe. In addition, the Flucast tool was modified and adapted for southern and northern hemisphere countries with regular seasonal patterns, and these are presented in [Multimedia Appendices 5 and 6](#).

Table 3. Comparison of the five models and their corresponding seasonal influenza predictions.

Year	Actual impact of season	Prediction of seasonal impact by scoring criteria				
		Model 1	Model 2	Model 3	Model 4	Model 5
2007	Severe					
Severity index		60	69	56	60	75
Season prediction		Severe	Severe	Moderate	Severe	Severe
Correct prediction		Yes	Yes	No	Yes	Yes
2008	Moderate					
Severity index		50	50	56	55	35
Season prediction		Moderate	Moderate	Moderate	Moderate	Moderate
Correct prediction		Yes	Yes	Yes	Yes	Yes
2009	Very severe (pandemic)					
Severity index		100	100	100	100	100
Season prediction		Pandemic	Pandemic	Pandemic	Pandemic	Pandemic
Correct prediction		Yes	Yes	Yes	Yes	Yes
2010	Mild					
Severity index		25	25	25	30	30
Season prediction		Mild	Mild	Mild	Moderate	Moderate
Correct prediction		Yes	Yes	Yes	No	No
2011	Moderate					
Severity index		35	38	31	40	45
Season prediction		Moderate	Moderate	Moderate	Moderate	Moderate
Correct prediction		Yes	Yes	Yes	Yes	Yes
2012	Severe					
Severity index		65	63	63	65	75
Season prediction		Severe	Severe	Severe	Severe	Severe
Correct prediction		Yes	Yes	Yes	Yes	Yes
2013	Moderate					
Severity index		35	38	31	40	35
Season prediction		Moderate	Moderate	Moderate	Moderate	Moderate
Correct prediction		Yes	Yes	Yes	Yes	Yes
2014	Moderate					
Severity index		45	50	38	50	45
Season prediction		Moderate	Moderate	Moderate	Moderate	Moderate
Correct prediction		Yes	Yes	Yes	Yes	Yes
2015	Moderate					
Severity index		55	63	44	60	65
Season prediction		Moderate	Severe	Moderate	Severe	Severe
Correct prediction		Yes	No	Yes	No	No
2016	Moderate					
Severity index		35	44	25	40	35
Season prediction		Moderate	Moderate	Mild	Moderate	Moderate
Correct prediction		Yes	Yes	No	Yes	Yes
2017	Severe					

Year	Actual impact of season	Prediction of seasonal impact by scoring criteria				
		Model 1	Model 2	Model 3	Model 4	Model 5
Severity index		65	75	56	65	80
Season prediction		Severe	Severe	Moderate	Severe	Severe
Correct prediction		Yes	Yes	No	Yes	Yes
Predicted accuracy of past influenza seasons		11/11	10/11	8/11	9/11	9/11

Figure 1. The Flucast tool (online form).

Discussion

The Flucast tool provides early prediction of seasonal severity of influenza using real-time data. In our prediction tool, we found that five parameters were optimal and that using more or fewer parameters reduced the predictive ability of the Flucast tool. The value of Flucast is in allowing real-time prediction of seasonal severity of an upcoming season with a simple tool to inform surge capacity planning. Also, the development of the tool using 11 years of historical influenza data and validation against the 2018 influenza season prospectively adds strength to the predictive value of the tool.

Routinely collected data from influenza surveillance schemes are regularly used by public health sectors to monitor epidemiological trends and to inform the burden of influenza-related illnesses for the planning of public health intervention programs in many countries. These may differ from country to country depending on health care resources, policy, and regulations adopted within the local context. Similar to Australian Influenza Surveillance Reports, the CDC in the United States, the European Centre for Disease Control and Prevention, and WHO regularly publish updated influenza

surveillance data to inform current trends of influenza seasonal activity, circulating viral strains, disease impact on the health care system, and information regarding available vaccines and vaccination during the season and beyond. Although these data are descriptive and useful, they are not predictive. In this study, we have shown that it is possible to use the same data, combined with other parameters, to predict the seasonal severity of influenza. We understand that there are trade-offs between the use of sophisticated modeling techniques and a simple method in generating outputs for forecasting of influenza epidemics and outbreaks. Although studies have shown the potential benefits of using advanced modeling statistics in this area, most public health practitioners do not use such methods and rely on descriptive data [21]. There are many reasons for this, and some may be due to the lack of proper training or knowledge in modeling and uncertainty about modeling, which may hinder the efficient use of such tools [21]. There is also a need to engage health system stakeholders involved in operational response and to improve uptake of such tools for decision support.

There are some limitations to this study. First, the Flucast tool was developed using Australian data, and its application in other

countries or settings was not evaluated. For example, in developing countries with limited surveillance capacity, all parameters may not be available. In some countries such as Thailand or Hong Kong, clear winter seasonality of influenza is not present, and there may be two peaks in the influenza seasons. These may have an impact on the predictivity of the Flucast tool. Secondly, there are variations in the influenza surveillance scheme and availability of country-specific data; thus not all parameters may be applicable in the Flucast tool. Thirdly, qualitative assessments of virulence and vaccine mismatch were made using reports from the surveillance system, and changes in these data during the season might influence the accuracy of output by the tool. Fourthly, inconsistency and variations in reporting and surveillance practices, as well as regional variation in influenza activity between jurisdictions, could limit the regional validity of the tool. Increased notifications over time may be due to wider availability and uptake of influenza tests, and they may not necessarily reflect the high incidence of infection, which can also vary

subnationally. To overcome this problem in our study, we calibrated the input variables (that used laboratory-confirmed influenza notifications) based on the last 5 years' average rather than using the prior years. In addition, we used the crude population death rate attributable to influenza reported per year to adjust for testing or reporting practices in the administrative data. Lastly, due to the unpredictable nature of influenza infections, predicting seasonal influenza activity can be complicated. It is driven by many factors, such as the viral strain in the season, vaccine mismatch with the circulating strain, vaccination coverage in the population, as well as environmental factors such as temperature and humidity. Therefore, care should be taken in interpreting the results. These should be continually revised using new data as it becomes available.

To conclude, Flucast is a simple tool and is intended to provide simple outputs for routine practice by public health officials in a real-time setting with minimal supervision. The tool can be used to plan for health care services and resources during the influenza season.

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Authors' Contributions

CRM conceived and oversaw the study, provided the concept for the overall study design, and contributed to manuscript review and writing; AMM designed the study, tested and developed the models, and wrote the first draft of the manuscript; DJM, AAC, and XC contributed to manuscript review and writing.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Model 2, with removal of a seasonal onset column from model 1.

[[DOCX File, 17KB - publichealth_v5i3e11780_app1.docx](#)]

Multimedia Appendix 2

Model 3, removal of an influenza-associated deaths column from model 1.

[[DOCX File, 17KB - publichealth_v5i3e11780_app2.docx](#)]

Multimedia Appendix 3

Model 4, using different scoring method for dominant circulating strain in model 1.

[[DOCX File, 18KB - publichealth_v5i3e11780_app3.docx](#)]

Multimedia Appendix 4

Model 5, using the number of influenza notifications in June instead of May in model 1.

[[DOCX File, 18KB - publichealth_v5i3e11780_app4.docx](#)]

Multimedia Appendix 5

The Flucast tool: parameters and scoring criteria for southern hemisphere countries.

[[DOCX File, 15KB - publichealth_v5i3e11780_app5.docx](#)]

Multimedia Appendix 6

The Flucast tool: parameters and scoring criteria for northern hemisphere countries.

[[DOCX File, 15KB - publichealth_v5i3e11780_app6.docx](#)]

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Abbreviations

CDC: Centers for Disease Control and Prevention

NNDSS: National Notifiable Diseases Surveillance System

WHO: World Health Organization

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Review

Communicating Science in the Digital and Social Media Ecosystem: Scoping Review and Typology of Strategies Used by Health Scientists

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Abstract

Background: The public's understanding of science can be influential in a wide range of areas related to public health, including policy making and self-care. Through the digital and social media ecosystem, health scientists play a growing role in public science communication (SC).

Objective: This review aimed to (1) synthesize the literature on SC initiated by health scientists targeting the public in the digital and social media ecosystem and (2) describe the SC strategies and communication channels used.

Methods: This scoping review was based on the Joanna Briggs Institute Methodological Framework. A systematic search was performed in 6 databases (January 2000 to April 2018). Title and abstract screening, full-text review, data charting, and critical appraisal were performed independently by two review authors. Data regarding included studies and communication channels were synthesized descriptively. A typology of SC strategies was developed using a qualitative and inductive method of data synthesis.

Results: Among 960 unique publications identified, 18 met inclusion criteria. A third of publications scored good quality (6/18, 33%), half scored moderate quality (9/18, 50%), and less than a fifth scored low quality (3/18, 16%). Overall, 75 SC strategies used by health scientists were identified. These were grouped into 9 types: content, credibility, engagement, intention, linguistics, planification, presentation, social exchange, and statistics. A total of 5 types of communication channels were identified: social networking platforms (eg, Twitter), content-sharing platforms (eg, YouTube), digital research communities (eg, ResearchGate), personal blogs and websites (eg, WordPress), and social news aggregation and discussion platforms (eg, Reddit).

Conclusions: Evidence suggests that multiple types of SC strategies and communication channels are used by health scientists concurrently. Few empirical studies have been conducted on SC by health scientists in the digital and social media ecosystem. Future studies should examine the appropriateness and effectiveness of SC strategies for improving public health-related outcomes

and identify the barriers, facilitators, and ethical considerations inherent to the involvement of health scientists in the digital and social media ecosystem.

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KEYWORDS

health communication; public health; social media; internet; patient participation

Introduction

Background

The public's understanding of science can be influential in a wide range of areas related to public health, including policy making and self-care [1,2]. Although the public uses digital and social media primarily to network and nurture social connections, individuals are frequently exposed to various types of information related to, for instance, politics and health [3]. Thus, some organizations suggest scientists should use their expertise and influence to communicate science in the digital and social media ecosystem to change people's health-related attitudes, behaviors, and policy preferences [4]. However, this task is complexified by the prevalence of misinformation on social media and the ease with which this content can be propagated to audiences targeted by increasingly sophisticated algorithms [3].

Science communication (SC), in the context of health sciences, is a process of knowledge exchange about health-related scientific information or viewpoints [4]. SC falls within the broader domain of the mass communication of scientific and biomedical evidence including, among other things, health communication interventions, numeracy, and health literacy [4-7]. The process of SC encompasses multiple stakeholders, integrates strategies and goals operationalized through various communication channels, and involves numerous audiences. In recent years, a new dimension emerged in the SC literature: the direct relationship between scientists and laypeople (hereafter *the public*) [2,8,9].

The internet is the primary source of information for almost 70% of the public looking for information about scientific topics [10]. Through the growth of digital and social media, new, direct, and powerful communication channels between scientists and the public were enabled, allowing for the disintermediation of SC [10]. Disintermediation refers to the public's direct access to scientific information from scientists through the social and digital media ecosystem, a process that would otherwise require a human mediator such as a journalist [11,12]. Health scientists are thus increasingly expected to perform SC, often as an institutional requirement, or to integrate SC in their research program [10]. However, SC can be a complex endeavor as it is tailored to the motives, time commitments, and resources of each scientist and the information that they intend to communicate [4]. In light of this, several health scientists seek information and resources on how to communicate science.

Indeed, although health scientists are used to communicating science to their peers, they might be less familiar with the use of appropriate SC strategies and communication channels with the public [13]. In this context, questions arise regarding how

health scientists should effectively engage the public in SC through the social and digital media ecosystem. Effective public communication of science requires specialized knowledge and skills. Multiple factors contribute to the complexity of SC. First, scientific information is complex, and people perceive and process this information in different ways. Thus, different SC strategies may be used for audiences with variable levels of science literacy. Second, the process of SC involves uncertainty, "either in the science itself or its implications or as a result of various communicators conveying different, and sometimes contradictory, messages" [4]. Health scientists must consider the appropriate strategies to convey this uncertainty during the process of SC. Third, social influences play an important part in SC, a phenomenon that may be exacerbated when science is communicated in the digital and social media ecosystem. Indeed, social networks affect people's beliefs, attitudes, and behaviors [4].

Objectives

To our knowledge, no review has previously attempted to identify the nature and extent of the evidence regarding SC initiated by health scientists in the digital and social media ecosystem. Thus, the primary objective of this scoping review was to describe the nature and the extent of the literature regarding SC initiated by health scientists and targeting the public in the digital and social media ecosystem. The secondary objective of this scoping review was to describe the SC strategies and communication channels used by health scientists in this context.

Methods

Methodological Framework

We planned and conducted this scoping review following the Joanna Briggs Institute Methodological Framework [14]. Scoping reviews aim to "examine the extent (that is, size), range (variety), and nature (characteristics) of the evidence on a topic or question" [15]. This scoping review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews [15].

Protocol and Registration

We previously published the protocol of this scoping review [12]. There was no registration of the protocol as scoping reviews are not eligible according to the International Prospective Register of Systematic Reviews. In this study, we present an abridged version of the methods employed.

Eligibility Criteria

We included any type of literature (eg, gray literature and original research paper) published in English or in French,

between 2000 and 2018, if the inclusion criteria were met regarding population, concept, and context.

Population

We considered the literature reporting SC strategies involving disintermediation used by health scientists with the public. Regarding health scientists, we included literature about scientists in all health disciplines, as defined by the classification of the World Health Organization (eg, medicine, dentistry, pharmacy, and psychology) [16]. Regarding the public, we included literature involving the public at large (ie, laypeople) or specific sociodemographic groups (eg, teenagers, young adults, and women). However, we excluded the literature involving specifically patients and students as other fields of study relate directly to these populations (ie, patient education and health sciences education).

Concept

We included the literature that described a process of SC involving health scientists and the public operationalized through communication channels in the digital and social media ecosystem.

A recent typology summarized 4 types of SC [17]. Type 1 (professional SC) refers to knowledge exchanged among scientists. Type 2 (deficit SC) refers to knowledge unidirectionally exchanged from scientists to the public. Type 3 (consultative SC) refers to knowledge exchanged bidirectionally and iteratively between scientists and the public. Type 4 (deliberative SC) is defined as “knowledge exchanged in a democratic and deliberative manner in which the principal actors have equal standing, and scientific knowledge and local knowledge are mutually respected” [17]. Type 1 is thus beyond the scope of this review as it does not involve the public. We adopted a broad definition of SC that encompasses all types of SC involving scientists and the public (types 2, 3, and 4). We defined SC as an interactive process of knowledge exchange between scientists and the public using SC strategies through various communication channels.

Furthermore, we defined a SC strategy as any plan or action adopted by scientists (eg, using humor, disseminating research findings using images, and telling a story) to communicate science.

Context

We included sources reporting SC strategies used by scientists with the public in the digital and social media ecosystem about any topic or area related to clinical aspects of health.

Information Sources and Search

We drafted the search strategy with an experienced librarian. We first developed the search strategy for PubMed (see [Multimedia Appendix 1](#)) and then translated it for other databases. The search strategy used a combination of 3 concepts: (1) scientists and the public; (2) health SC; and (3) disintermediation, which refers to the communication channels in the digital and social media ecosystem. We searched 6 bibliographical databases from January 2000 up until April 2018: Cumulative Index to Nursing and Allied Health Literature, via EBSCOhost; Excerpta Medical Database, via Ovid;

International Bibliography of the Social Sciences, via ProQuest; PubMed, via the National Center for Biotechnology Information; Sociological Abstracts, via ProQuest; and Web of Science—Science Citation Index and Social Sciences Citation Index, via the Institute for Scientific Information—Thomson Scientific. We also searched relevant gray literature sources, trial registries, and journals. Finally, we screened the reference lists of included records to identify additional records. We exported search results into EndNote V8.0 (Clarivate Analytics), and we removed duplicates.

Selection of Sources of Evidence

We worked independently and in duplicate (GF and AL or TM) to screen titles and abstracts and resolved disagreements through consensus. We then performed the full-text review of potentially eligible articles using the same method (GF and GR or MAMC or JBP).

Data Charting Process

A data charting form was developed specifically for this review. A total of 6 review authors were involved in the data charting process (GF, AL, MAMC, TM, GR, and JBP). Thus, to ensure accuracy and prevent inconsistencies, we completed a pretest of the data charting process, after which adjustments were made to the data charting form. Clarifications regarding the type of publication and how to assess the quality of the articles were the main changes made. Working in teams of 2, reviewers independently charted the data, discussed the results, and completed a “consensus” form for each included publication.

Data Items

We extracted the following data items:

- Article characteristics (eg, year of publication, first author’s academic discipline, country of origin, publication type, and aim)
- SC-related items (eg, SC definition, SC type, SC theoretical framework, SC goal, SC context, SC strategies used or described, SC communication channels used or described, SC plan development process, and SC delivery)
- Study methods, if applicable (eg, study design, population, sample size, data collection and analysis method, and article limits)
- Key results related to SC

Critical Appraisal of Individual Sources of Evidence

Although critical appraisal of the included publications was not originally planned [12], review authors consensually decided to add this step to further qualify the literature. We critically appraised empirical works, which are original research articles and literature reviews, based on general guidance (eg, coherence between the problem described and the methods retained, adequate sample in terms of participants or the literature selected, and rigor of the data collection or extraction process). To critically appraise nonempirical types of articles (eg, editorials and viewpoints), we retained the Joanna Briggs Institute Critical Appraisal Checklist for Text and Opinion Papers [18].

Synthesis of Results

We first synthesized data regarding the nature and the extent of the literature regarding SC initiated by health scientists in the digital and social media ecosystem in a table format. Then, we synthesized narratively data regarding SC-related data items (eg, communication channels).

To develop a typology of SC strategies, we used a qualitative and inductive method of data synthesis, with a constant comparison approach [19]. This method of data synthesis allowed the types of SC strategies to emerge from the available data and not from prespecified categories. First, we listed in a single file all SC strategies identified in included publications. Second, 2 reviewers (GF and MAMC) consensually attached a provisional label to each SC strategy to identify its type or, in other words, its focus. For example, the strategy “Developing a plan for engaging the targeted audience” was labeled “Planification,” and the strategy “Use numbers instead of words when possible” was labeled “Linguistics.” Third, all provisional types of SC strategies identified during this first round were

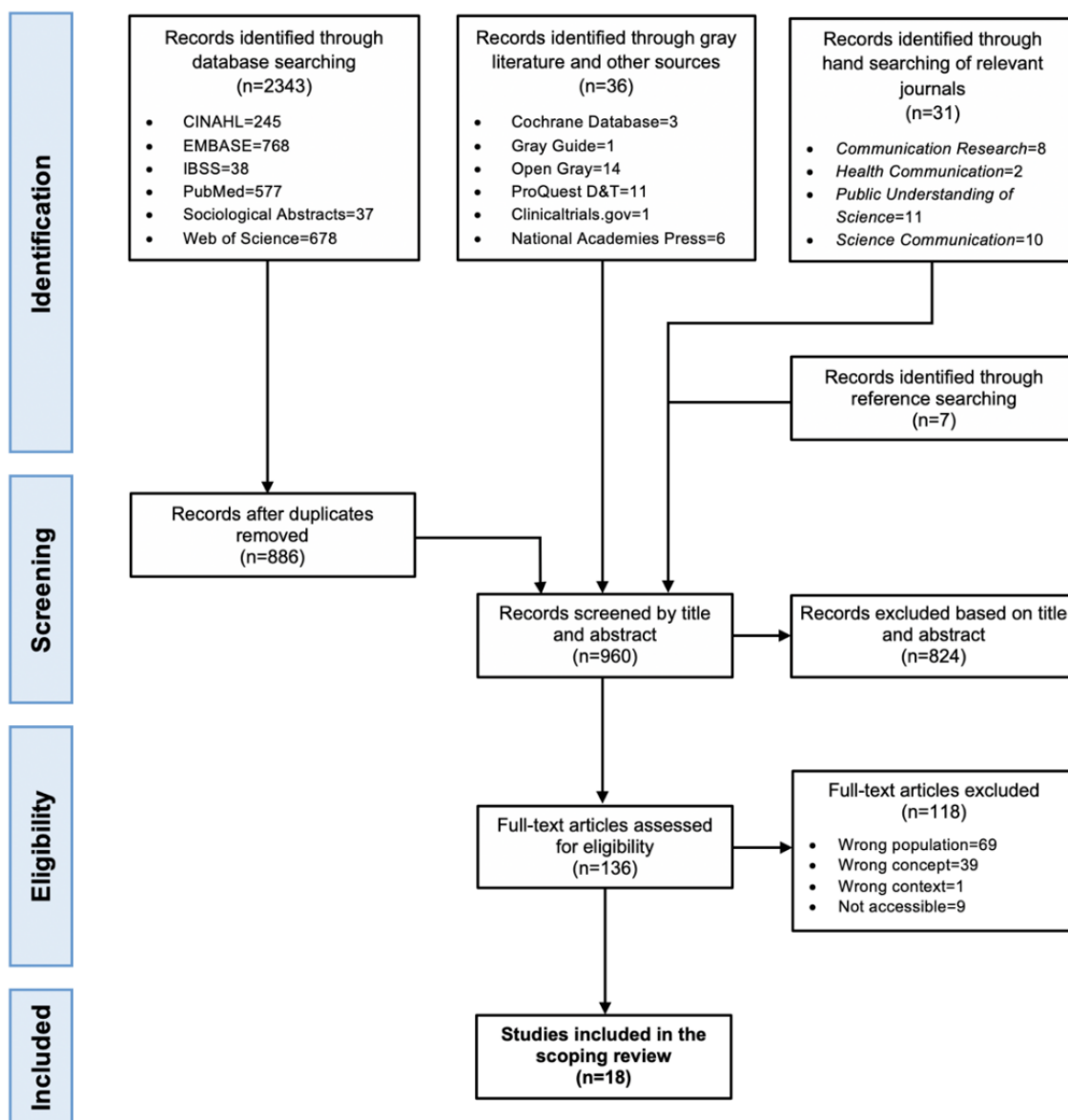
compared and contrasted to identify similar ones and regroup those with similar focus. For example, the provisional types of SC strategies labeled “Structure” and “Presentation” were grouped together under the latter. Indeed, all SC strategies dealing with the structure of the information to be disseminated were closely related to the visual presentation of the information. Finally, the proposed typology was sent to a third reviewer experienced in qualitative data synthesis (AB) not involved yet in the previous steps for validation.

Results

Selection of Sources of Evidence

From a pool of 960 unique publications, we assessed 136 full texts for eligibility, and we included 18 publications that described a process of SC operationalized in the digital and social media ecosystem involving health scientists and the public, as illustrated in the PRISMA study flow diagram [20] in Figure 1.

Figure 1. Study flow diagram. CINAHL: Cumulative Index to Nursing and Allied Health Literature; EMBASE: Excerpta Medical Database; IBSS: International Bibliography of the Social Sciences; D&T: Dissertations and Theses.



Characteristics of Sources of Evidence

The characteristics of included sources of evidence are reported in [Table 1](#). Overall, publications originated from a wide variety of disciplines. Types of publications were varied; we included primary research articles (4/18, 21%), conference proceedings (4/18, 21%), primary research abstracts (2/18, 11%), reports (2/18, 11%), discussion papers (2/18, 11%), an editorial (1/18, 5%), a review (1/18, 5%), a scientific poster (1/18, 5%), and a quality improvement paper (1/18, 5%). The aims of publications were also varied: 7 discussed the benefits and implications of using social media for communicating science to the public [21-26]; 3 studies aimed to develop, test, and disseminate lay summaries of evidence [27-29]; 2 publications aimed to discuss various prospects, priorities, and strategies for improving SC with the public [4,10]; 1 publication summarized articles regarding prospects for SC in the Web 2.0. era [30]; 1 publication presented international SC experiences [31]; 1 publication aimed to provide guidance on how to identify the public's information needs and conduct deliberative SC [32]; 1 publication advocated for adopting a community-partnered

participatory research approach to SC [33]; 1 publication aimed to develop and evaluate a Web-based research advisory community [34]; and 1 publication aimed to explore the concept of science literacy in relation to SC [35]. We also identified the type of SC described in each publication according to the classification of Palmer and Schibeci [17]. A total of 6 publications (6/16, 38%) described *deficit SC* (type 2), 4 publications (4/16, 25%) described *consultative SC* (type 3), and 6 publications (6/16, 38%) described *deliberative SC* (type 4). We were unable to determinate the type of SC for 2 publications. Only 2 publications (2/18, 16%) referred to a theoretical framework. Archibald and Clark [21] suggested using the Diffusion of Innovations Theory [36] to promote understanding of how scientists use social media and offer insight for increasing its use in academic settings by considering the 5 characteristics of innovation: relative advantage, compatibility, complexity, trialability, and observability. Russell and Sprung [34] based the development of their Web-based research advisory community on the model of knowledge translation proposed by Holmes and Scarrow [37].

Table 1. Characteristics of sources of evidence.

First author or institution, year; country	Academic background of the first author	Publication type	Publication aim	Type of SC ^a
Archibald, 2014 [21]; Canada	Nursing	Editorial	To describe how Twitter and the Diffusion of Innovation Theory can help uptake of nursing research	Deficit SC (type 2)
Barnfield, 2017 [27]; United Kingdom	Biomedical sciences	Primary research article	To select a series of studies from the Newcastle Cognitive Function after Stroke cohort and create lay summaries comprehensible and accessible to the public	Consultative SC (type 3)
Bin, 2012 [22]; Australia	Epidemiology	Primary research abstract	To explore the relative costs and benefits of communicating sleep research using social media to a lay audience	NR ^b
Bodison, 2015 [33]; United States	Occupational science	Conference proceedings	To advocate for the use of CPPR ^c practices in dissemination, implementation, and improvement science and to offer insight about barriers and solutions to CPPR success in a large, urban community	Deliberative SC (type 4)
Breland, 2017 [23]; United States	Implementation science and psychology	Discussion paper	To describe 5 benefits for public health scientists of disseminating their work via social media	Deficit SC (type 2)
Finch, 2012 [24]; Australia	Sports medicine	Primary research abstract	To describe experiences over the past months of using Twitter, LinkedIn, and blogging and summarize some of the approaches that can be used with these social media tools and show how to encourage interaction among scientists, practitioners, and general public	NR
Fordis, 2011 [30]; United States	Medicine	Conference proceedings	To summarize key articles regarding prospects for Web 2.0 technologies for engagement, communication, and dissemination in the era of patient-centered outcomes research	Deliberative SC (type 4)
Glenton, 2010 [28]; Norway	Implementation science	Primary research article	To develop and test a summary of evidence that a consumer audience would understand and obtain feedback about different versions of a format for a Plain Language Summary of a Cochrane Systematic Review	Deficit SC (type 2)
Lafferty, 2015 [25]; United Kingdom	Medical education	Review	To review some of the emerging evidence and commentaries on the adoption and role of social media in research, which may inform their further application in medical and health care research	Consultative SC (type 3)
Miranda, 2014 [31]; United Kingdom	Hygiene and tropical medicine	Scientific poster	To present dissemination experiences from the Artemisinin-based Combination Therapy Consortium, a global research partnership with 25 projects in 10 countries aiming to improve malaria drug delivery and use	Deficit SC (type 2)
National Academy of Sciences, Engineering and Medicine, 2013 [32]; United States	Multiple disciplines	Conference proceedings	To describe colloquiums that brought together leading social, behavioral, and decision scientists to familiarize one another, other scientists, and communication practitioners with current research that can improve the communication of science to lay audiences	Deliberative SC (type 4)
National Academy of Sciences, Engineering and Medicine, 2016 [10]; United States	Multiple disciplines	Conference proceedings	To summarize the workshop's presentations and discussions, and it recounts what workshop participants identified as key lessons, practical strategies, and the needs and opportunities for applying the principles of health literacy to the precision medicine	Deliberative SC (type 4)

First author or institution, year; country	Academic background of the first author	Publication type	Publication aim	Type of SC ^a
National Academy of Sciences, Engineering and Medicine, 2017 [4]; United States	Multiple disciplines	Report	To offer a research agenda for science communicators and researchers seeking to apply this research and fill gaps in knowledge about how to communicate effectively about science, with a particular focus on issues that are contentious in the public sphere	Deliberative SC (type 4)
Rowe, 2017 [26]; United States	Nutrition	Discussion paper	To offer some insight into the effect that rapidly evolving social and other digital media may have on the various perceptual influences on SC in the field of nutrition	Deficit SC (type 2)
Russell, 2016 [34]; Canada	Kinesiology and pediatrics	Quality improvement project paper	To describe the development and evaluation of a Web-based research advisory community, hosted on Facebook and connecting a diverse group of parents of special needs children with researchers at CanChild Centre for Childhood Disability Research	Deliberative SC (type 4)
Santesso, 2015 [29]; Canada	Nutrition	Primary research article	To compare a new format of a patient summary of evidence from a systematic review with the current narrative format and evaluate if it improves understanding, accessibility of the information, and whether it is preferred over other versions by patients and the public	Deficit SC (type 2)
Snow, 2016 [35]; United States	Psychology and education	Report	To consider how the definition of science literacy has expanded and shifted over time to accommodate changing ideas about science	Consultative SC (type 3)
Tunnecliff, 2015 [38]; Australia	Physiotherapy	Primary research article	To explore health scientists' and clinicians' current use of social media and their beliefs and attitudes toward the use of social media for communicating research evidence	Consultative SC (type 3)

^aSC: science communication.

^bNot reported.

^cCPPR: community-partnered participatory research.

Critical Appraisal of Individual Sources of Evidence

Results of the critical appraisal of individual sources of evidence are presented in [Table 2](#). Overall, 6 publications scored good quality (6/18, 33%), 9 scored moderate quality (9/18, 50%), and 3 scored low quality (3/18, 16%). Regarding the quality of empirical studies, 1 criterion in particular was unclear: if the sample size used was adequate to reach the study goal. Regarding the quality of other types of publications, 2 criteria were often unclear or not properly reported. First, there was often no reference during the discussion to the extant literature in the field of SC to contrast or support the author's opinion. Second, incongruences with the cited sources were often not logically defended by the author, undermining the credibility of the opinion.

Results of Individual Sources of Evidence

We identified 9 types of SC strategies used by health scientists with the public in the digital and social media ecosystem: content, credibility, engagement, intention, linguistics, planification, presentation, social exchange, and statistics. Definitions and examples of each type of SC strategy are presented in [Table 3](#). Results suggest health scientists use a wide variety of SC strategies, with different purposes. Some strategies are related to the content and credibility of the message, some are related to linguistics and statistics to improve the public's understanding of science, whereas others aim to increase engagement and social exchange related to science in the social and digital media ecosystem.

Table 2. Quality of included sources of evidence.

First author or institution, year	Empirical studies and literature reviews				Other types of publications						Overall quality
	Coherence between problem, purpose, methods, and results?	Research process meets scientificity criteria?	Sample adequate to reach goal?	Data collection and analysis rigorous?	Source of the opinion clearly identified?	Source of the opinion has standing in the field of expertise?	Interests of the relevant population the central focus?	Stated position the result of an analytical process?	Reference to the extant literature?	Any incongruence with the sources logically defended?	
Archibald, 2014 [21]	— ^a	—	—	—	Yes	Unclear	Yes	Yes	Yes	Unclear	Good
Barnfield, 2017 [27]	Yes	Yes	Unclear	Unclear	—	—	—	—	—	—	Moderate
Bin, 2012 ^b [22]	Yes	Yes	Unclear	Yes	—	—	—	—	—	—	Moderate
Bodison, 2015 [33]	—	—	—	—	Yes	Unclear	Yes	Yes	Unclear	Unclear	Moderate
Breland, 2017 [23]	—	—	—	—	Yes	Unclear	Yes	Unclear	No	No	Moderate
Finch, 2012 ^b [24]	—	—	—	—	Yes	Unclear	Unclear	Unclear	No	No	Low
Fordis, 2011 [30]	—	—	—	—	Yes	Yes	Yes	Yes	Unclear	No	Good
Glenton, 2010 [28]	Yes	Unclear	Unclear	Unclear	—	—	—	—	—	—	Moderate
Lafferty, 2015 [25]	Yes	Unclear	Unclear	Unclear	—	—	—	—	—	—	Low
Miranda, 2014 [31]	—	—	—	—	Yes	Unclear	No	No	Unclear	No	Low
NASEM, 2013 [32]	—	—	—	—	Yes	Yes	Unclear	Unclear	No	Unclear	Moderate
NASEM, 2016 [10]	—	—	—	—	Yes	Unclear	Yes	Unclear	Yes	No	Moderate
NASEM, 2017 [4]	—	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes	Good
Rowe, 2017 [26]	—	—	—	—	Yes	Yes	Yes	Unclear	No	Unclear	Moderate
Russell, 2016 [34]	Yes	Unclear	Yes	Yes	—	—	—	—	—	—	Good
Santesso, 2015 [29]	Yes	Yes	Unclear	Yes	—	—	—	—	—	—	Moderate
Snow, 2016 [35]	—	—	—	—	Yes	Yes	Yes	Yes	Yes	No	Good
Tunnecliff, 2015 [38]	Yes	Yes	Unclear	Yes	—	—	—	—	—	—	Good

^aCells are empty for publications where these particular criteria were not applicable.

^bIt was difficult to critically appraise primary research abstracts as key information may be excluded by authors for space considerations. Thus, the evaluation of overall quality should be interpreted with caution.

Table 3. Proposed typology of science communication strategies used by health scientists in the digital and social media ecosystem.

Type	Definition	Examples of each type of strategy
Content	Strategies to specify the type of health science–related content to be communicated	Announce new studies, research articles, and findings [10,21,23,24] and publish commentaries on health-related research [24]
Credibility	Strategies to support the credibility of health science–related content to be communicated	Present the confidence in the results (quality of evidence) on a scale [28,29] and disclose the sources of research funding [32]
Engagement	Strategies to increase public engagement with health science–related content to be communicated	Use hashtags [21,23,25] and update frequently [10,22]
Intention	Strategies to personalize health science–related content according to certain specific objectives or to convey a specific message	Make information actionable, that is, specify when to engage in an action and embed a trigger [32] and consider the usefulness of the research findings for the target audience [4,27,32]
Linguistics	Strategies to determine the linguistic microcomponents of the textual scientific information to be communicated	Minimize the use of, or replace, scientific jargon [27,28,31] and avoid acronyms [31]
Planification	Strategies to plan the operationalization of science communication, often in function of the audience(s) targeted	Develop a plan for engaging the targeted audience [10,33] and develop a YouTube channel devoted to disseminating research progress and findings along the way [33]
Presentation	Strategies to determine the structure and the visual presentation of the health science–related content to be communicated	Include pictures and, to a lesser extent, graphs [27] keep sentences and paragraphs short [31]
Social exchange	Strategies to increase and guide social exchanges related to the health science–related content	Encourage discussion, participation, and engagement [10,34,35] and converse with other users on topics related to health science on digital and social media [22]
Statistics	Strategies to determine the format of numeric and statistical scientific information	Present natural frequencies rather than percentages and probabilities [28] and be consistent in the numeric formats used [28]

After elimination of duplicates, 75 unique SC strategies distributed among the 9 types presented in Table 3 were identified in 15 of the publications reviewed (see Multimedia Appendix 2). No strategies were identified in 3 publications [26,30,38]. Only 13 strategies (13/75, 17%) were cited more than once: “Announcing new studies, research articles and findings” (*content*), “Use hashtags” (*engagement*), “Consider the usefulness of the research findings for the target audience” (*intention*), “Minimize the use of, or replace, scientific jargon” (*linguistics*), “Encourage discussion, participation and engagement on digital and social media” (*social exchange*), “Present the confidence in the results (quality of evidence) on a scale” (*credibility*), “Update frequently” (*engagement*), “Consider the interests of the target audience in the communication of research findings” (*intention*), “Arouse emotion” (*intention*), “Use a set of standard qualitative statements to express the magnitude of the effect” (*linguistics*), “Develop a plan for engaging the targeted audience” (*planification*), “Create and disseminate of summaries” (*content*), and “Use a question and answer layout” (*presentation*).

Interestingly, some SC strategies in the types *statistics* and *presentation* diverge. For instance, the strategies “Omit numbers” and “Use numbers instead of words when possible,” as well as “Omit tables” and “Use tables instead of narratives” appear contradictory.

Communication channels in the digital and social media ecosystem can be classified into 5 types underlining their primary purpose: (1) social networking platforms (ie, Twitter, Facebook, LinkedIn, Instagram, Google+, and Snapchat); (2) content-sharing platforms (ie, YouTube, Flickr, Scribd, and

Slideshare); (3) digital research communities (ie, ResearchGate, Academia, and FigShare); (4) personal blogs and websites (ie, WordPress); (5) and social news aggregation and discussion platforms (ie, Reddit). The most frequently cited communication channels in reviewed publications were Twitter (n=13), blogs (n=9), Facebook (n=9), personal websites (n=6), YouTube (n=5), LinkedIn (n=3), Reddit (n=3), and Instagram (n=2).

Discussion

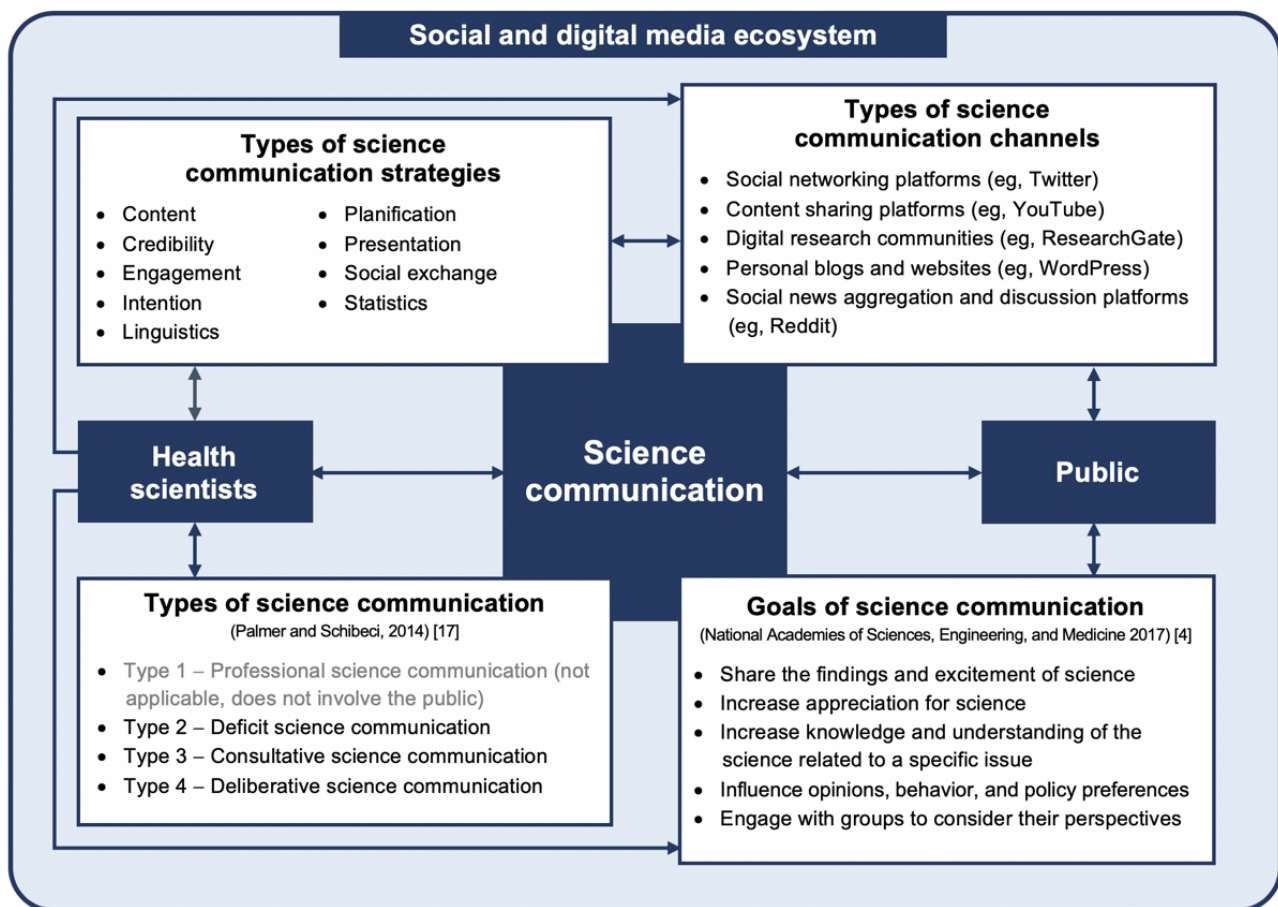
Summary of Evidence

This scoping review identified 18 publications that described a process of SC involving health scientists and the public operationalized in the digital and social media ecosystem. We identified 75 unique SC strategies and classified these into 9 types: content, credibility, engagement, intention, linguistics, planification, presentation, social exchange, and statistics. Moreover, we identified 5 types of communication channels in the digital and social media ecosystem: social networking platforms, content-sharing platforms, digital research communities, personal blogs and websites, and social news aggregation and discussion platforms.

To contextualize the results in relation with previous findings, we propose a schematization of the process of SC between health scientists and the public in the digital and social media ecosystem (see Figure 2). Health scientists, SC, and the public are the central concepts, and 4 elements are on the periphery: (1) the 9 types of SC strategies identified in this review; (2) the 5 types of communication channels in the digital and social media ecosystem identified in this review; (3) the 4 types of SC as described by Palmer and Schibeci [17]; and (4) the goals of

SC as described by the National Academies of Sciences, Engineering, and Medicine [4].

Figure 2. Schematization of the process of science communication between health scientists and the public in the digital and social media ecosystem.



According to reviewed literature, health scientists should aim to make scientific information useful for the public. This is a challenge, as the validity and usefulness of clinical studies has been previously debated. Indeed, critics point that health scientists often fail in either addressing an important health problem, generating new knowledge, or in producing rigorous research [39]. A total of 30% of health scientists think that less than half of the published literature in their field is reproducible, shedding light on the confidence scientists have in others' findings [40]. Thus, this may impede scientists' willingness to engage the public in SC. Employing SC strategies related to *planification, content, intention*, as identified in this review, could strengthen the process of SC. Indeed, by integrating SC in their research program and identifying prospectively the type of content to communicate and the objectives of SC, health scientists could improve the usefulness of scientific information for the public.

The expertise and trustworthiness of the person conveying a message have a strong effect on information credibility perceived by the general public [41]. In digital and social media, scientific information is often shared by the public and its validity is often questionable [23,42]. Diverging perceptions and opinions are fueled by appealing to ideologies or emotions rather than scientific facts. Indeed, reviewed literature suggests that scientific information that leads to amazement or fear in people is more likely to be shared than information that leads

to sadness [4,32]. Asserting the *credibility* of the message by employing SC strategies underlining, for instance, the expertise of the scientist conveying the message and the confidence in the findings may help in counteracting messages that are not based on evidence.

In the context of SC, social exchanges between users must be encouraged to foster engagement with science but must also be framed by certain principles. We identified several SC strategies that may be used to increase *social exchanges* and foster the *engagement* of the public with health science. However, ethical principles to consider when using social media for SC were mentioned in only 1 reviewed article, in which authors referred more specifically to confidentiality and respect during online exchanges [34]. This is surprising considering that several reviews underline ethical issues surrounding the use of digital technology by health care professionals, such as boundary issues and potential conflicts of interests [4,43,44]. The extent to which these principles can be applied to health scientists has not been examined yet. Tensions between institutions' social media policy and academic freedom could potentially discourage scientists from taking an active role in SC [45]. Further research should focus on identifying ethical principles regarding the use of digital and social media by health scientists.

Numeracy and health literacy are 2 concepts closely linked to SC that influence the public's ability to properly evaluate health-related scientific information [46]. Contradictory findings

were found with regard to SC strategies related to the *presentation* of information, *linguistics*, and the use of *statistics*. Although Glenton and Santesso [28] and Santesso and Rader [29] suggest the use of tables and the inclusion of numbers in SC, Barnfield and Pitts [27] and the National Academy of Sciences [32] suggest favoring a narrative format. More research is needed to identify the best strategies for facilitating the public's understanding of scientific information through optimal presentation, linguistics, and statistics.

Engaging the public in the process of developing a SC plan is crucial to consider their needs and interests. In this review, 6 out of 18 publications mentioned including the public at some point in the development process of a SC plan. However, only 1 publication described how the public was involved in the process. In this study, members of the public participated in a focus group where they were invited to comment on lay summaries [27]. We expected the public to be more involved in the process of SC in reviewed studies. Indeed, several governmental organizations advocate for a conception of SC that is democratic and in which the principal actors have equal standing. Health scientists should strive for bidirectional communication by involving the targeted audience at the inception of a SC initiative.

Strengths and Limitations

Strengths of this scoping review include the prospective publication of the protocol [12]. Moreover, the review was planned and conducted using a rigorous methodological framework [14] and was reported according to the PRISMA extension for scoping reviews to enhance replicability [15]. Although the scoping review methodology usually does not encompass quality assessment, we decided to include it to guide further research.

Limitations of this scoping review include the difficulty in synthesizing data from diverse sources of evidence. Few

included sources of evidence were original research articles, and only 1 study employed an experimental design. Assessing publication quality proved difficult, considering the variability of publication types. Finally, differentiating the concept of SC from health literacy while performing the screening process proved to be a complex endeavor, the latter referring to individuals' capacity to understand health information, and not science per se [35].

Conclusions

Communicating findings of health research to the public is crucial to support self-care and to inform governmental decision making. Health scientists play a growing role in SC with the growth of digital and social media. This scoping review identified 75 SC strategies used by health scientists in the digital and social media ecosystem, which were categorized in 9 types. Results suggest health scientists currently use concurrently multiple SC strategies with a wide variety of purposes.

However, this scoping review identified that few empirical works have been conducted in this field. Further research should identify the barriers, facilitators, and ethical considerations inherent to the involvement of health scientists in the digital and social media ecosystem. Moreover, further research should focus on methods to increase public engagement with the health-related content shared (eg, through emotions) and developing and evaluating interventions to optimize the public's understanding of complex notions related to science (ie, recognizing uncertainty, assessing the quality of evidence, qualifying the nature, and quantifying the strength of a relationship between 2 variables). Efforts should be undertaken to examine the appropriateness and effectiveness of the SC strategies used to improve public health-related outcomes. Conducting research in these areas may help to move beyond the deficit model of SC through the engagement of the public and consideration of its needs, interests, knowledge, and skills.

Acknowledgments

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Search strategy for PubMed.

[PDF File (Adobe PDF File), 20KB - [publichealth_v5i3e14447_app1.pdf](#)]

Multimedia Appendix 2

Science communication strategies identified in reviewed publications, classified by type.

[PDF File (Adobe PDF File), 212KB - [publichealth_v5i3e14447_app2.pdf](#)]

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Abbreviations

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SC: science communication

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Original Paper

Bridging Awareness and Acceptance of Pre-Exposure Prophylaxis Among Men Who Have Sex With Men and the Need for Targeting Chemsex and HIV Testing: Cross-Sectional Survey

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Abstract

Background: Pre-exposure prophylaxis (PrEP) is currently an important tool for HIV prevention, especially in communities with higher risk of infection, notably men who have sex with men (MSM). To date, PrEP has remained generally unavailable in many cities around the world. In the planning of strategies for PrEP targeting MSM, community assessment is crucial to understand members' responses to the new intervention.

Objective: Awareness and acceptance are 2 different but intricately linked contexts of PrEP. The aim of this study was to identify the determinants of awareness and acceptance of PrEP among MSM and to delineate their interrelationships in Hong Kong where PrEP services have not been developed.

Methods: A Web-based questionnaire survey was administered in light of the popularity of the internet as a platform for information and networking in the MSM community. Factors associated with PrEP acceptance and awareness were separately analyzed, and their predictors were subsequently tested by multivariate logistic regression. Associations between acceptance and awareness of PrEP were examined by factor network analysis.

Results: Between August and September 2016, results from a total of 453 HIV-negative MSM were analyzed. Half (49.7%, 225/453) of the respondents were aware of PrEP, and 78.3% (355/453) would consider using PrEP when it becomes available. Awareness of PrEP was associated with recent ($P=.01$) and ongoing ($P=.04$) use of psychotropic drugs for sex (chemsex). MSM who used online forums to seek sex partners had lower awareness ($P=.04$) than those visiting physical venues for sex networking. MSM who accepted PrEP were more likely users of internet channels for sex networking ($P=.049$), especially location-based social network apps ($P=.04$). MSM accepting PrEP were more concerned about their partners' HIV status ($P=.002$), history of sexually transmitted infections ($P=.01$), condom use ($P=.02$), and HIV testing behavior ($P=.02$). Multivariate logistic regressions revealed that PrEP awareness was related to one's networking pattern, whereas its acceptance was associated with inclination to self-protect from HIV. Factor network analysis highlighted the importance of chemsex, which was linked by over half of the edges, whereas the rest were contributed by HIV testing behaviors.

Conclusions: In Hong Kong, the overall awareness among MSM toward PrEP was only moderate but their acceptance was higher. Targeting MSM with chemsex behaviors through Web-based platforms and parallel development of tailored HIV testing services are important when introducing PrEP in the community.

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KEYWORDS

pre-exposure prophylaxis; men who have sex with men; HIV; health knowledge, attitudes, practice; psychotropic drugs

Introduction

Globally, the HIV epidemic is continuing to grow among men who have sex with men (MSM). In Hong Kong, a notable increase in the number of MSM diagnosed with HIV infection has been seen since 2004 [1], contributing to 63% of all reported new cases in 2017 [2]. Although condom use is the most important measure to prevent HIV infection, its rates were suboptimal, ranging from 60% to 80% for the last anal sex with various types of partners [3]. Having condomless sex was associated with lower self-efficacy of consistent condom use, higher perceived barriers against condom use [4], and other situational and environmental phenomena, such as alcohol use, overseas sex, and not at home [5]. Despite its high efficacy for HIV prevention, barriers to condom use commonly exist. In circumstances where a condom is unavailable or not used for various reasons, other measures against HIV infection would need to be in place. To *end AIDS by 2030*, The Joint United Nations Programme on HIV/AIDS proposed that, inter alia, 90% of people by 2020 should have access to a package of prevention options, the latter referring to a multitude of measures, including pre-exposure prophylaxis (PrEP) [6].

PrEP was first approved for HIV prevention by the US Food and Drug Administration in 2012, followed by recommendations by the World Health Organization in 2014 [7]. Since then, demonstration projects grew rapidly worldwide, although the uptake has been slow [8]. Before rolling out PrEP in the community, it is important to assess MSM's awareness and acceptance and their relationships with demographics and sexual and networking behaviors. In Asia and the Pacific, awareness of PrEP in the MSM community has so far been low (5% in Myanmar [9], 11% in China [10], 40% in Taiwan [11], and 44% in Malaysia [12]) and their acceptance of PrEP varied (39% in Malaysia [12], 56% in Taiwan [13], 62% in Myanmar [9], and 68% in China [10]). Awareness and acceptance are 2 different yet interrelated contexts of PrEP. Studies suggested that HIV testing history, demographic characteristics, networking pattern, and perceived discrimination against people living with HIV were associated with the magnitude of PrEP awareness [14,15]. Acceptance of PrEP was, on the contrary, associated with risk behaviors such as a higher number of sex partners and inconsistent condom use, use of psychotropic drugs for sex (chemsex), and perceptions about one's own HIV risk and efficacy of PrEP [9-12,16]. Moreover, the association between awareness and acceptance of PrEP was inconsistently reported. Significant association was reported among MSM in Malaysia [12] and Taiwan [11], and a marginal effect was observed in China [10] but no relationship was found in the United Kingdom [14].

With the increasing availability of PrEP worldwide, it is anticipated that the awareness of PrEP among MSM would increase. Identifying the factors associated with not only awareness but also acceptance of PrEP is important so that maximum health benefits could be achieved by addressing the community's specific health needs and sexual behaviors. This study aimed to assess the MSM community's awareness and acceptance of PrEP and the factors associated with their interrelationships in Hong Kong, an Asia Pacific city where

PrEP is not yet generally available. The study involved post hoc analyses of data collected from a cross-sectional study on the HIV testing behaviors of MSM. Results from this study will help inform promotion and intervention strategies and enhance the understanding of the health needs of potential PrEP users.

Methods

Participants

The study was based on the post hoc analyses of data collected for an HIV prevention study targeting MSM living in Hong Kong. The details of survey administration and primary analysis have been described previously [17]. Briefly, between August and September 2016, MSM were recruited through an online forum and location-based social network (LBSN) mobile apps, the target audience of which were MSM. Subjects were eligible if they were male, had ever had sex with another male, were aged 18 years or above, were normally residing in Hong Kong, and were able to understand Chinese. An incentive in the form of an HK \$25 coffee voucher (US \$1=HK \$7.8) was given upon completion of the questionnaire. Informed consent was obtained from all participants included in the study. This study was approved by the Survey and Behavioural Research Ethics Committee of The Chinese University of Hong Kong.

Measures

Sociodemographic and Risk Profiles

The sociodemographic items collected were age, height, weight, ethnicity, place of origin, residing and working district, education level, employment status, monthly income, self-perceived body image types, sexual orientation and role, age of sexual debut, chemsex history and current habit, sexually transmitted infection (STI) history (including syphilis, gonorrhoea, chlamydia, genital warts, herpes, and pubic lice), HIV testing history and recency, HIV status, and use of PrEP and post-exposure prophylaxis.

Sexual Behaviors With the Most Recently Acquainted Male Sex Partner

The time, location, and channel of getting to know the most recently acquainted male sex partner were gathered, with the partner's characteristics as listed in the above subsection. With regard to the sex act, the corresponding location, venue, and condom and drug use were enquired.

Networking Behaviors

The use of internet channels or physical venues in the preceding 3 months was enquired. Internet channels included online forums and websites and LBSN targeting MSM and social groups in mobile communication apps such as Line, WhatsApp, and Telegram. Types of physical venues were sauna, bar, beach, public toilet, gym, massage center, and social functions.

Factors Considered When Choosing Male Sex Partners

A number of factors were asked if they had been taken into account when choosing male sex partners. If a factor was considered important, inquiry was made on the corresponding expected criteria, including age, height, weight, sexual role, body image type, sexual orientation, place of origin, ethnicity,

education level, employment status, marital status, chemsex habit, HIV testing habit, HIV status, STI history, condom usage, and place of having sex.

Perceptions About Pre-Exposure Prophylaxis

Following a brief description of PrEP ([Multimedia Appendix 1](#)), awareness and acceptance of PrEP were assessed as the 2 key outcome measures in this study. Awareness was assessed by a trichotomized question, which could be translated as “before answering this questionnaire, how much did you know about PrEP?” One of the following 3 options could be chosen: *never heard of*, *was aware of it but did not know much*, and *had keen knowledge of*. The latter 2 responses were regarded as indicative of awareness of PrEP, whereas the first option was treated as unawareness. Acceptance was assessed by responses to questions on the preferred modality of PrEP (daily, event driven, time driven, or injection). Answers other than *would not consider taking PrEP* were regarded as willingness to use PrEP.

Statistical Analyses

Self-reported HIV-positive participants were excluded from the analysis. All the variables included in the analyses were dichotomized, and their relationships with awareness and acceptance of PrEP were separately assessed with the chi-square test. If the expected count of a cell was less than 5, the Fisher exact test was used. A *P* value of less than .05 was considered significant in all analyses. To predict MSM’s awareness and acceptance of PrEP, significant factors were entered to separate multivariate logistic regression models and selected by backward elimination based on the likelihood ratio until the level of change became lower than .10. If a direct relationship between awareness and acceptance was not observed, their indirect relationships were explored by first identifying factors directly correlated with awareness and acceptance by significant phi coefficients. If no specific factors were associated with both awareness and acceptance, pairwise correlation between factors significantly associated with either awareness or acceptance were tested and only significant ones were retained, thus creating a bipartite graph, with 1 set of nodes representing variables significantly associated with awareness and another set with acceptance. Links (edges) connecting nodes between the 2 sets denoted significant associations. The variables’ network characteristics were measured by normalized degree centrality, that is, the proportion of edges connected to a particular node.

Results

Of the 459 complete responses collected (completion rate=71%, of 647 nonduplicate responses collected), 6 self-reporting HIV-positive MSM were excluded. Data from the remaining 453 participants were available for analysis. Participants’ characteristics are shown in [Table 1](#). Of them, 249 (55.0%) participants were aged 25 years or younger; 270 (59.6%) had a monthly income of less than HK \$15,000; 249 (55.0%) and 131 (28.9%) were full-time workers and students, respectively; 79 (17.4%) attained secondary-level education or below; and 359 (79.2%) were gay. About two-thirds (293/453, 64.6%) of them had previously been tested for HIV. In total, 56 (12.4%) and 51 (11.3%) participants had been diagnosed with STIs and had

chemsex, respectively. Three-quarters (346/453, 76.4%) of them had sought sex partners in the previous 3 months.

Overall, 225 (49.7%, *N*=453) MSM had ever heard of PrEP. MSM’s awareness of PrEP was not associated with their demographic characteristics ([Table 2](#)). History of HIV testing, STI diagnosis, and chemsex history were not associated with awareness either. Recent (odds ratio [OR] 2.64, 95% CI 1.01-6.94; *P*=.04) and current (OR 2.91, 95% CI 1.20-7.07; *P*=.01) engagement in chemsex were both associated with higher odds of PrEP awareness. Associations between MSM’s awareness of PrEP and their networking behaviors varied. Higher awareness was observed in MSM who, in the preceding 3 months, had sought partners outside Hong Kong (OR 1.55, 95% CI 1.02-2.34; *P*=.04), and it was lower in those who used online forums (OR 0.68, 95% CI 0.46-0.99; *P*=.04) for sex networking. An insignificant difference in the low awareness of MSM who sought partners in local physical venues was noted (33% vs 28%). MSM who were aware of PrEP were more likely to expect their partners to have a regular HIV testing habit (OR 1.90, 95% CI 1.23-2.92; *P*=.003). Partners’ health status, including HIV testing habit and status, and STI history were not associated with their awareness. Among these factors, recent chemsex habit (adjusted odds ratio [aOR] 3.28, 95% CI 1.32-8.14; *P*=.01), partner seeking through online forums (aOR 0.63, 95% CI 0.43-0.94; *P*=.02) and outside Hong Kong (aOR 1.66, 95% CI 1.08-2.54; *P*=.02) in the preceding 3 months, and expecting partners to be tested regularly (aOR 1.97, 95% CI 1.26-3.06; *P*=.003) were significant predictors of MSM’s awareness of PrEP.

Over three-quarters (78.4%, 355/453) of the participants responded that they would consider taking PrEP in the future. Acceptance was associated with working or studying fulltime (OR 2.19, 95% CI 1.27-3.78; *P*=.004) but not with other demographic variables ([Table 2](#)). MSM who had tested for HIV before (OR 1.68, 95% CI 1.06-2.65; *P*=.03) and those who had engaged in group sex (OR 1.68, 95% CI 1.04-2.69; *P*=.03) were more likely to accept PrEP. Those whose only partners in the past year were emotionally attached ones had a lower acceptance (OR 0.32, 95% CI 0.16-0.62; *P*<.001). MSM using internet channels (OR 1.61, 95% CI 1.00-2.60; *P*=.049), especially mobile apps (OR 1.60, 95% CI 1.01-2.51; *P*=.04), had a higher acceptance of PrEP. MSM who accepted PrEP considered their partner’s health status, including HIV testing habit (OR 1.99, 95% CI 1.13-3.52; *P*=.02), HIV status (OR 3.03, 95% CI 1.49-6.17; *P*=.002), STI history (OR 2.13, 95% CI 1.16-3.91; *P*=.01), and condom use habit (OR 3.88, 95% CI 2.10-7.17; *P*<.001), important when seeking partners. They also considered their partner’s education level (OR 1.66, 95% CI 1.05-2.62; *P*=.03) important. Though they were perceived to be important, expectations of the partner’s regular testing habit and consistent condom use were not associated with PrEP acceptance. In the multivariate regression model, working or studying fulltime (aOR 2.36, 95% CI 1.33-4.22; *P*=.004), having been tested for HIV (aOR 1.58, 95% CI 0.98-2.56; *P*=.06), having an emotionally attached partner as the only sex partner in the previous year (aOR 0.27, 95% CI 0.13-0.56; *P*<.001), and considering partner’s condom use habit important (aOR 4.08, 95% CI 2.15-7.75; *P*<.001) were predictors of PrEP acceptance.

Table 1. Characteristics of men who have sex with men in a cross-sectional survey in Hong Kong (N=453).

Variable	n (%)
Age (years)	
≤25	249 (55.0)
>25	204 (45.0)
Monthly income	
<HK \$15,000 (approximately US \$1910)	270 (59.6)
≥HK \$15,000	183 (40.4)
Employment status	
Full-time working	249 (55.0)
Full-time studying	131 (28.9)
Working or studying part-time, freelance, self-employed, unemployed, or retired	73 (16.1)
Education level	
Secondary level or below	79 (17.4)
Postsecondary level or above	374 (82.6)
Sexual orientation	
Gay	359 (79.2)
Bisexual	90 (19.9)
Heterosexual	4 (0.9)
HIV testing history	
Ever tested	293 (64.6)
Never tested	160 (35.4)
STI^a history	
Ever diagnosed with STI	56 (12.4)
Never diagnosed with STI	397 (87.6)
Chemsex history	
Ever had chemsex	51 (11.3)
Never had chemsex	402 (88.7)
Sought partners in the last 3 months	
Yes	346 (76.4)
No	107 (23.6)

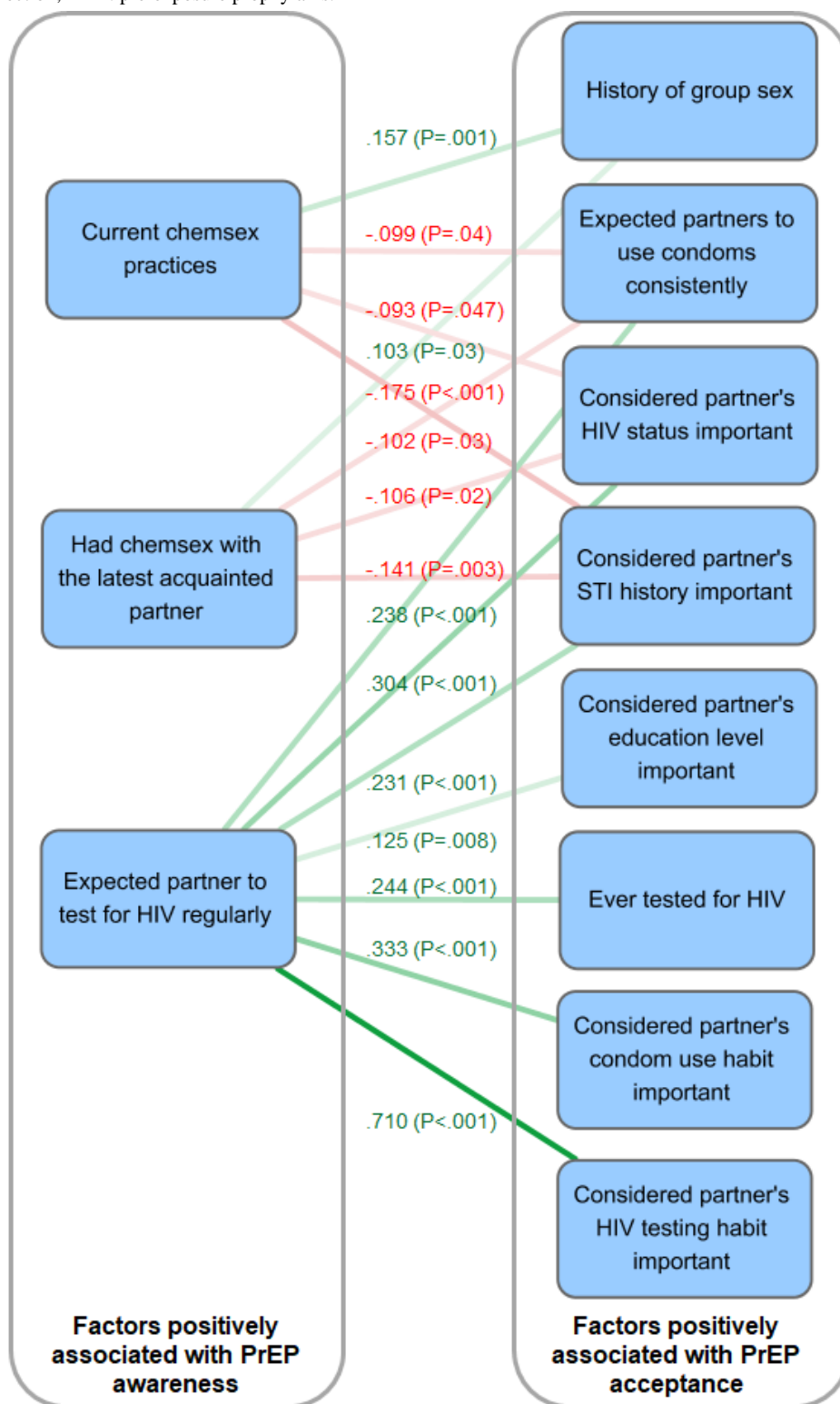
^aSTI: sexually transmitted infection.

Table 2. Univariate analysis of the factors associated with the awareness and acceptance of pre-exposure prophylaxis (N=453).

Variable	Aware of PrEP ^a				Will consider using PrEP			
	Yes (n=225)	No (n=228)	OR ^b (95% CI)	P value	Yes (n=355)	No (n=98)	OR (95% CI)	P value
Demographics								
Aged 25 years or below	130 (57.8)	119 (52.2)	1.25 (0.87-1.82)	.23	199 (56.1)	50 (51.0)	1.23 (0.78-1.92)	.38
Monthly income <HK \$15,000 (US \$1=HK \$7.8)	136 (60.4)	134 (58.8)	1.07 (0.74-1.56)	.72	208 (58.6)	62 (63.3)	0.82 (0.52-1.30)	.40
Full-time working or studying	184 (81.8)	196 (86.0)	0.73 (0.44-1.21)	.23	307 (86.5)	73 (74.5)	2.19 (1.27-3.78)	.004
Attained postsecondary or above education level	189 (84.0)	185 (81.1)	1.22 (0.75-1.99)	.42	299 (84.2)	75 (76.5)	1.64 (0.95-2.83)	.08
Gay	183 (81.3)	176 (77.2)	1.29 (0.82-2.03)	.28	279 (78.6)	80 (81.6)	0.83 (0.47-1.46)	.51
Risk profiles								
Ever tested for HIV	154 (68.4)	139 (61.0)	0.39 (0.94-2.05)	.10	239 (67.3)	54 (55.1)	1.68 (1.06-2.65)	.03
Ever diagnosed with STI ^c	31 (13.8)	25 (11.0)	1.30 (0.74-2.28)	.36	47 (13.2)	9 (9.2)	1.51 (0.71-3.20)	.28
Ever had group sex	98 (43.6)	88 (38.6)	0.85 (0.59-1.24)	.40	155 (43.7)	31 (31.6)	1.68 (1.04-2.69)	.03
Ever had chemsex	30 (13.3)	21 (9.2)	1.52 (0.84-2.74)	.17	43 (12.1)	8 (8.2)	1.55 (0.70-3.42)	.27
Having a chemsex habit currently	15 (6.7)	6 (2.6)	2.64 (1.01-6.94)	.04	18 (5.1)	3 (3.1)	1.69 (0.49-5.86)	.59 ^d
Last sex partner used drugs	19 (8.4)	7 (3.1)	2.91 (1.20-7.07)	.01	22 (6.2)	4 (4.1)	1.55 (0.52-4.62)	.43
Boyfriend as the only sex partner in the previous year	19 (8.4)	20 (8.8)	0.96 (0.50-1.85)	.90	22 (6.2)	17 (17.3)	0.32 (0.16-0.62)	<.001
Networking behaviors in the past 3 months								
Ever sought partners	177 (78.7)	169 (74.1)	1.29 (0.83-1.99)	.26	278 (78.3)	68 (69.4)	1.59 (0.97-2.62)	.07
Sought partners outside Hong Kong	73 (32.4)	54 (23.7)	1.55 (1.02-2.34)	.04	107 (30.1)	20 (20.4)	1.68 (0.98-2.89)	.06
Sought partners in local physical venues	74 (32.9)	63 (27.6)	1.28 (0.86-1.92)	.22	109 (30.7)	28 (28.6)	1.11 (0.68-1.81)	.68
Sought partners through internet channels	166 (73.8)	161 (70.6)	1.17 (0.78-1.78)	.45	264 (74.4)	63 (64.3)	1.61 (1.00-2.60)	.049
Sought partners in online forums	75 (33.3)	97 (42.5)	0.68 (0.46-0.99)	.04	133 (37.5)	39 (39.8)	0.91 (0.57-1.43)	.67
Sought partners in mobile apps	153 (68.0)	136 (59.6)	1.44 (0.98-2.11)	.06	235 (66.2)	54 (55.1)	1.60 (1.01-2.51)	.04
Factors considered important when choosing partners								
Partner's HIV testing habit	197 (87.6)	189 (82.9)	1.45 (0.86-2.45)	.16	310 (87.3)	76 (77.6)	1.99 (1.13-3.52)	.02
Expectation of partner's regular HIV testing habit	181 (80.4)	156 (68.4)	1.90 (1.23-2.92)	.003	271 (76.3)	66 (67.3)	1.05 (0.50-2.22)	.89
Partner's HIV status	208 (92.4)	210 (92.1)	1.05 (0.53-2.09)	.89	335 (94.4)	83 (84.7)	3.03 (1.49-6.17)	.002
Partner's STI history	199 (88.4)	199 (87.3)	1.12 (0.63-1.96)	.71	319 (89.9)	79 (80.6)	2.13 (1.16-3.91)	.01
Partner's condom use habit	205 (91.1)	199 (87.3)	1.49 (0.82-2.73)	.19	329 (92.7)	75 (76.5)	3.88 (2.10-7.17)	<.001
Expectation of partner's consistent condom use habit	159 (70.7)	169 (74.1)	0.84 (0.56-1.27)	.41	266 (74.9)	62 (63.3)	1.74 (1.08-2.79)	.02
Partner's education level	118 (52.4)	102 (44.7)	1.36 (0.94-1.97)	.10	182 (51.3)	38 (38.8)	1.66 (1.05-2.62)	.03

^aPrEP: pre-exposure prophylaxis.^bOR: odds ratio.^cSTI: sexually transmitted infection.^dFisher exact test.

Figure 1. Bipartite factor network of variables associated with awareness and acceptance of pre-exposure prophylaxis among men who have sex with men in Hong Kong. Edge colors correspond to the labeled phi coefficients, where positive correlations are in green and negative ones are in red. STI: sexually transmitted infection; PrEP: pre-exposure prophylaxis.



Overall, 81% MSM who had heard of PrEP responded that they would consider taking PrEP. Among those who did not know about PrEP before, 76% indicated that they would consider it in the future after the brief introduction of PrEP. The association between PrEP awareness and acceptance was not significant (OR 1.35, 95% CI 0.86-2.11; P=.20). As awareness of PrEP was not directly associated with its acceptance, nor was there

a variable significantly associated with both variables, correlations between factors separately associated with awareness and acceptance were tested (Figure 1). There were 3 and 8 factors that could be correlated with PrEP awareness and acceptance, respectively, constituting a total of 15 edges. Awareness was positively correlated with current (phi=0.096; P=.04) and recent (phi=0.116; P=.01) chemsex practices and

expecting their partner to test for HIV regularly ($\phi=0.138$; $P=.003$). The 2 chemsex-related variables had a normalized degree centrality of .267. They were both positively correlated with group sex history ($\phi=0.157$; $P=.001$ and $\phi=0.103$; $P=.03$) and negatively correlated with the expectation of sex partners to use condoms consistently ($\phi=-0.099$; $P=.04$ and $\phi=-.102$; $P=.03$) and with concerns on sex partners' HIV status ($\phi=-0.093$; $P=.047$ and $\phi=-0.106$; $P=.02$) and STI history ($\phi=-0.175$; $P<.001$ and $\phi=-0.141$; $P=.003$). Conversely, the latter 3 variables were positively correlated with the expectation of partner's regular testing habit ($\phi=0.238$, $P<.001$; $\phi=0.304$, $P<.001$; and $\phi=0.231$, $P<.001$), which had the highest normalized degree centrality (.467). It was also positively correlated with considerations of partners' education level ($\phi=0.125$; $P=.008$), condom use habits ($\phi=0.333$; $P<.001$) and HIV test habits ($\phi=0.710$; $P<.001$), and one's history of HIV testing ($\phi=0.244$; $P<.001$).

Discussion

Principal Findings

In Hong Kong, where PrEP has not yet been formally introduced, only half of the MSM in the community were aware of PrEP, but a high proportion (78%) were willing to take PrEP should it become available. The moderate level of awareness observed was similar to that reported in Taiwan and Malaysia, where awareness levels were 40% and 44%, respectively [11,12]. However, the high acceptance was comparable with Mainland China [10], Brazil [18], and Kenya [19]. Although awareness and acceptance are 2 important attributes for engaging MSM in PrEP for achieving HIV prevention, their predictors were different. Our results suggest that awareness of PrEP is associated with one's networking behaviors and risk profiles. Those who were aware of PrEP were more likely to be active on the Web and to seek partners overseas.

In the past few years, popular mobile LBSN apps in Hong Kong, such as Hornet, have incorporated a feature of stating the HIV status on each user's profile [20]. Statuses including HIV negative, HIV positive, undetectable virus level, and on PrEP could be chosen. Early adopters who were using PrEP had most likely networked with overseas MSM at a time when PrEP was not readily available. Some of them may be open about their PrEP status and have it disclosed on their profile. Information about PrEP and its implementation may also be more abundant in some neighboring countries such as Australia and Thailand [21] and that the latter had actually been enabling foreigners to have access to PrEP while traveling. Previous studies had confirmed that the internet was the main source of PrEP information [22]. Our results also highlighted the distinct pattern of information flow through different Web-based channels. Forum visitors had a lower awareness (33%), whereas mobile app users had a higher (68%) awareness level.

Conversely, PrEP awareness of MSM using online forums was particularly low. We noted that those who engaged in high-risk sexual activities, especially chemsex, had higher odds of knowing about PrEP. Chemsex was associated with a higher risk of HIV infection [23]. MSM who engaged in chemsex generally did not expect their partners to use condoms

consistently. Such behaviors, together with other risk behaviors such as group sex, might have increased one's perceived risk of HIV infection, thus contributing to their exploration of alternative means of HIV prevention. In other words, MSM with a low risk perception may think that their prevention measures were already sufficient [24].

Willingness to use PrEP, in general, was associated with an inclination to self-protect from HIV infection. They were not only more aware of their HIV status but also concerned about partner's health status and behaviors, such as HIV status, STI history, and condom use and HIV testing habits. However, high-risk behavior per se was not associated with PrEP acceptance. This implies that MSM who were interested in PrEP were likely those who were concerned about their own health but not necessarily those with a higher actual risk [25]. Those who only had sexual relationships with their romantic partners may have a low perceived risk [26] that they did not think they would need PrEP. An unstable lifestyle pattern may imply an unstable income source that may become a barrier for them to access health care services, including PrEP. Other than cost, types of service providers may play a role in facilitating PrEP provision and affecting MSM's acceptance toward PrEP, especially to those who work shifts. A separate study noted a lower acceptance (45%) if it was given free by local public health services [27]. Further investigation into MSM's preferences on service provider is warranted.

As awareness and acceptance were not directly associated, an understanding of the pathways that link them is crucial. In our study, 2 specific forms of activities on these pathways, that is, chemsex and HIV testing, were found to be particularly important. MSM engaging in chemsex were paying little attention to their partner's health status or condom use. As they are prone to HIV infection, efforts to scale up PrEP uptake among chemsex-practicing MSM are more likely to be successful in view of their higher awareness. The second important activity was HIV testing. Those who had undergone testing would be expecting the same from their partners. They were relatively more concerned about their own health and were more open to PrEP as an effective way for prevention. It has been shown that voluntary counseling and testing (VCT) clients who were aware of PrEP were more willing to start using it [11]. Such services could be a point of access to not only promote but also provide preparatory screening for renal function and hepatitis B infection in addition to HIV for efficient linkage to PrEP [12].

Limitations

There were several limitations to this study such that extrapolation of its results is cautioned. First, some networking and behavioral questions referred to what happened in the preceding 3 months, so recall bias may exist. Second, sensitive questions such as sexual behaviors and drug use may induce social desirability bias. As our questionnaire was self-administered on the Web, the bias should have been minimized. On the contrary, the administration of the survey on the Web may cause self-selection bias, as only MSM inclined to respond to internet-based questions would participate in the study. Third, the main focus of the study was HIV testing

behaviors, whereas PrEP was included as a new form of preventive intervention for which the awareness was assessed by a relatively simple trichotomized question. Its interpretation for inferring awareness about PrEP may not be robust for drawing a definitive conclusion. Finally, as PrEP was not available at that time through public services or implementation studies, willingness to use PrEP expressed by the respondents remained speculative.

Conclusion

In conclusion, the networking channels were essential in affecting MSM's awareness of PrEP in the community. Their low awareness warrants the specific development of community education, not only for information provision but also for the

linkage to access channels, should it become available. In the future, when PrEP studies are piloted, collaboration with VCT services would be needed, and subjects' sexual health needs, especially STI induced by chemsex and condomless sex, should be well addressed. Although VCT services could be convenient starting points, outreach activities targeting MSM engaging in chemsex would be good opportunities for enrolling risk-taking individuals to use PrEP. Such high-risk networks could indeed be an effective platform for developing HIV preventive interventions. The linkage between awareness and acceptance of PrEP highlighted the public health importance of taking on a targeted approach in identifying high-risk individuals for accessing PrEP.

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Authors' Contributions

THK analyzed the data, interpreted the results, and wrote the first draft of the paper. SSL conceptualized the study, interpreted the results, and critically revised the paper. Both authors approved the final draft.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Brief description of pre-exposure prophylaxis used in the study.

[[PDF File \(Adobe PDF File\), 62KB - publichealth_v5i3e13083_app1.pdf](#)]

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Abbreviations

aOR: adjusted odds ratio

LBSN: location-based social network

MSM: men who have sex with men
OR: odds ratio
PrEP: pre-exposure prophylaxis
STI: sexually transmitted infection
VCT: voluntary counseling and testing

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Corrigenda and Addenda

Authorship Correction: Factors Associated With Willingness to Use Pre-Exposure Prophylaxis in Brazil, Mexico, and Peru: Web-Based Survey Among Men Who Have Sex With Men

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(*JMIR Public Health Surveill* 2019;5(3):e15504) doi:[10.2196/15504](https://doi.org/10.2196/15504)

In “Factors Associated With Willingness to Use Pre-Exposure Prophylaxis in Brazil, Mexico, and Peru: Web-Based Survey Among Men Who Have Sex With Men” (*JMIR Public Health Surveill* 2019;5(2):e13771), the metadata information for author Cristina Pimenta (listed in 8th position) was accidentally overwritten by a duplicate of author Marcos Benedetti (listed in 9th position) when attempting to correct the spelling of Marcos’ surname.

Authorship was previously as follows:

Thiago Silva Torres, Kelika A Konda, E Hamid Vega-Ramirez, Oliver A Elorreaga, Dulce Diaz-Sosa, Brenda Hoagland, Steven Diaz, Marcos Benedetti, Marcos Bennedeti, Hugo Lopez-Gatell, Rebeca Robles-Garcia, Beatriz Grinsztejn, Carlos Caceres, Valdilea G Veloso, ImPrEP Study Group

The duplicate name and associated information for the author in 8th position has been adjusted to list Cristina Pimenta, PhD,

with affiliation “Brazilian Ministry of Health, Brasília, Brazil”, and the spelling of “Bennedeti” for the author in 9th position has been corrected to “Benedetti”. Updated authorship is now as follows:

Thiago Silva Torres, Kelika A Konda, E Hamid Vega-Ramirez, Oliver A Elorreaga, Dulce Diaz-Sosa, Brenda Hoagland, Steven Diaz, Cristina Pimenta, Marcos Benedetti, Hugo Lopez-Gatell, Rebeca Robles-Garcia, Beatriz Grinsztejn, Carlos Caceres, Valdilea G Veloso, ImPrEP Study Group

The correction will appear in the online version of the paper on the JMIR website on July 18, 2019, together with the publication of this correction notice. Because this was made after submission to PubMed, PubMed Central, and other full-text repositories, the corrected article also has been resubmitted to those repositories.

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Corrigenda and Addenda

Title Correction: Using a Call Center to Reduce Harm From Self-Administration of Reproductive Health Medicines in Bangladesh: Interrupted Time-Series

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Correction of: <https://publichealth.jmir.org/2019/3/e12233/>

(*JMIR Public Health Surveill* 2019;5(3):e15902) doi:[10.2196/15902](https://doi.org/10.2196/15902)

The title of this paper (*JMIR Public Health Surveill* 2019;5(3):e12233) has been changed from “Using a Call Center to Reduce Harm From Self-Administration of Abortion Medicines in Bangladesh: Interrupted Time-Series” to “Using a Call Center to Reduce Harm From Self-Administration of Reproductive Health Medicines in Bangladesh: Interrupted Time-Series”.

The title was changed by the editorial office to enhance clarity. The authors are concerned that the edited title suggested that the call center supports abortions, which is not the case. The

call centre supports administration of menstrual regulation medications. The authors also wish to emphasize that Marie Stopes Bangladesh does not provide abortion medications. The organization provides menstrual regulation services

The corrections will appear in the online version of the paper on the JMIR website on August 19, 2019, together with the publication of this correction notice. Because this was made after submission to PubMed and Crossref, the corrected article also has been resubmitted to those repositories.

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Corrigenda and Addenda

Update on Schnelle et al and Expression of Editorial Concern

JMIR Editorial Office

Related Articles:Correction of: <https://www.researchprotocols.org/2017/11/e234/>Correction of: <https://publichealth.jmir.org/2018/1/e6/>Correction of: <https://www.researchprotocols.org/2018/5/e10469/>Correction of: <https://publichealth.jmir.org/2018/2/e53/>*(JMIR Public Health Surveill 2019;5(3):e16314)* doi:[10.2196/16314](https://doi.org/10.2196/16314)

Background

The Office of the Deputy Vice-Chancellor at the University of Queensland (UQ) has concluded its research misconduct investigation regarding the two papers, hereafter referred to as Paper 1 (the protocol in JMIR Research Protocols) [1] and Paper 2 (the results in JMIR Public Health and Surveillance) [2]. In short, the main findings were that no retraction is required.

There were issues with inadequate disclosure of conflict of interests on submission, as well as “honest” mistakes, both of which were fully addressed in the JMIR Expression of Editorial Concern, Correction of Conflict of Interest and Affiliation, and Data Corrections, which we published in both affected journals [3,4] in close consultation with the Committee on Publication Ethics (COPE), together with the updated conflict of interest statement and data corrections submitted by the authors. According to the Council of Science Editors (CSE), the purpose of an Expression of Editorial Concern is to draw attention to potential problems in a publication, “but it does not go so far as to retract or correct an article.” CSE continues that “an editor who has a significant concern about the reliability of an article but not enough information to warrant a retraction until an institutional investigation is complete will sometimes use an expression of concern” [5]. COPE’s guidelines encourage editors to consider an Expression of Editorial Concern if “they receive inconclusive evidence of research or publication misconduct by the authors” or if “an investigation is underway but a judgement will not be available for a considerable time” [6], which both fit the circumstances of this case.

Response

As the University of Queensland investigation is now complete, we are updating the Expression of Editorial Concern following the key findings of the university report, from which we cite below, together with our response, as follows:

University of Queensland:

The investigation established that a number of authors of the above-named publications have associations with Universal Medicine. The investigation found that the conflict of interest statements submitted with the papers, which were not subsequently published by JMIR, indicate that there is a potential for a conflict of interest but do not adequately declare the nature of the authors’ associations with Universal Medicine. Those associations were subsequently adequately detailed in the updated conflict of interest statement by the authors published in the JMIR Expression of Editorial Concern, Correction of Conflict of Interest and Affiliation, and Data Corrections (doi:10.2196/publichealth.9932).

JMIR response: The investigation confirms our concerns that the vaguely phrased originally submitted COI (disclosing that the authors are “insiders”) did “not adequately declare the nature of the authors’ associations with Universal Medicine”. No changes to the Expressions of Editorial Concern or corrections are deemed necessary because they point out exactly that concern. JMIR may not have accepted the papers if the editor and reviewers had been aware of the full extent of the authors’ COIs, or at least would have insisted on describing ways to manage the significant COIs of the authors.

University of Queensland:

In relation to the concern about statistical errors in Paper 2, the authors submitted a correction to JMIR prior to the University becoming aware of the concerns. In this instance the authors acted to correct the error as soon as possible after becoming aware of it. There is no evidence that these were more than honest mistakes. The errors were corrected in the JMIR Expression of Editorial Concern, Correction of Conflict of Interest and Affiliation, and Data Corrections (doi:10.2196/publichealth.9932)”

JMIR response: To reflect the UQ judgement that “there is no evidence that these were more than honest mistakes” we have

updated the Expressions of Editorial Concern [3,4] to remove the following paragraph:

Finally, we are very concerned that the original results paper contained large statistical errors inflating the effect sizes (now corrected, see data correction below), which the authors themselves corrected (see below). We are giving the authors the benefit of the doubt in assuming that these were honest mistakes and not intentional errors, but it casts further doubts on the level of oversight as well as vetting of the data by an independent person.

University of Queensland:

The investigation determined that there are errors in the language used to describe the status of the study in Paper 1. Specifically, Paper 1 describes a planned study as if it had not begun, but at the time of publication data collection had been completed. The investigation found that the inaccuracy in reporting

of the study status represents an inadvertent error. Nonetheless, the language used may give an inaccurate impression of the study status that requires correcting.

JMIR response: We have inserted the phrase “At the time of publication of this protocol, data collection has been completed” in the Methods section of the abstract and body of the protocol paper (Paper 1 [1]). In addition, we have added an IRRID (International Registered Report Identifier) to both papers [1,2], which indicate (through the prefix DE for “Data Existing”) that the data were already collected at the time as is now standard practice for all protocols we publish [7].

The correction will appear in the online version of the papers on the JMIR website on September 23, 2019, together with the publication of this correction notice. Because this was made after submission to PubMed, PubMed Central, and other full-text repositories, the corrected articles have also been resubmitted to those repositories.

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Abbreviations

CSE: Council of Science Editors

COPE: Committee on Publication Ethics

UQ: University of Queensland

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Original Paper

Estimating the Size of Key Populations in Kampala, Uganda: 3-Source Capture-Recapture Study

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Related Article:

This is a corrected version. See correction statement: <https://publichealth.jmir.org/2020/2/e19893/>

Abstract

Background: Key populations, including people who inject drugs (PWID), men who have sex with men (MSM), and female sex workers (FSW), are disproportionately affected by the HIV epidemic. Understanding the magnitude of, and informing the public health response to, the HIV epidemic among these populations requires accurate size estimates. However, low social visibility poses challenges to these efforts.

Objective: The objective of this study was to derive population size estimates of PWID, MSM, and FSW in Kampala using capture-recapture.

Methods: Between June and October 2017, unique objects were distributed to the PWID, MSM, and FSW populations in Kampala. PWID, MSM, and FSW were each sampled during 3 independent captures; unique objects were offered in captures 1 and 2. PWID, MSM, and FSW sampled during captures 2 and 3 were asked if they had received either or both of the distributed objects. All captures were completed 1 week apart. The numbers of PWID, MSM, and FSW receiving one or both objects were determined. Population size estimates were derived using the Lincoln-Petersen method for 2-source capture-recapture (PWID) and Bayesian nonparametric latent-class model for 3-source capture-recapture (MSM and FSW).

Results: We sampled 467 PWID in capture 1 and 450 in capture 2; a total of 54 PWID were captured in both. We sampled 542, 574, and 598 MSM in captures 1, 2, and 3, respectively. There were 70 recaptures between captures 1 and 2, 103 recaptures between captures 2 and 3, and 155 recaptures between captures 1 and 3. There were 57 MSM captured in all 3 captures. We sampled 962, 965, and 1417 FSW in captures 1, 2, and 3, respectively. There were 316 recaptures between captures 1 and 2, 214 recaptures between captures 2 and 3, and 235 recaptures between captures 1 and 3. There were 109 FSW captured in all 3 rounds. The estimated number of PWID was 3892 (3090-5126), the estimated number of MSM was 14,019 (95% credible interval (CI) 4995-40,949), and the estimated number of FSW was 8848 (95% CI 6337-17,470).

Conclusions: Our population size estimates for PWID, MSM, and FSW in Kampala provide critical population denominator data to inform HIV prevention and treatment programs. The 3-source capture-recapture is a feasible method to advance key population size estimation.

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KEYWORDS

sex workers; men who have sex with men; substance-related disorders; HIV; population size

Introduction

Key populations, including people who inject drugs (PWID), men who have sex with men (MSM), and female sex workers (FSW), are disproportionately affected by the HIV epidemic. Compared with the general population, higher prevalences of HIV infection have been documented in these key populations because of high-risk sexual behaviors and injecting drugs [1-3].

Understanding the magnitude of the HIV epidemic among these populations requires accurate population estimates. These estimates inform the scale of prevention and treatment programs and are needed for resource allocation, monitoring, and evaluation of the programs [4,5]. Traditional methods of estimating the size of these populations, such as a census, are challenging because of the marginalized nature of these populations. Criminalization of sexual behaviors and drug use, in addition to human rights abuses, and severe stigma keep these populations socially hidden [6].

Even in Uganda's generalized epidemic, the high HIV prevalence observed in several studies of key populations suggests that they may account for a substantial number of HIV infections [7-9]. In Kampala, HIV prevalence among MSM was estimated at 13.7% and 31.3% among FSW in 2012 [8]. Studies among PWID have estimated the prevalence between 11% and 34% (report by Uganda Harm Reduction Network, 2017). Size estimates for PWID, FSW, and MSM in Uganda and Kampala, in particular, are scarce. Existing estimates for FSW and MSM (13,200 [95% confidence interval 10,200-16,200] and 7900 [95% credible interval (CI) 4400-11,300], respectively) in Kampala are outdated (2012) (report by The Crane Survey, 2012). Hospital data on people in drug abuse treatment suggest that there are 10 PWID per 100,000 people (or 70 to 80 people) in Kampala [10]. As a result, HIV services and policies to address population specific needs are likely underestimated and inadequate.

There are many methods to estimate population sizes, each with various strengths and limitations [4]. Capture-recapture (CRC) is one method that has been used in epidemiology [11-13] to estimate the size of key populations [14-17]. This method begins with an initial capture, as individual members of the target population are sampled, tagged, or offered a unique object, and released back into the population. A short period later (days or weeks), a second, independent capture is sampled; during this encounter, individuals will be assessed or asked whether they have been previously tagged, that is, received an object. Additional captures increase the number of data points from which estimates are generated, generally resulting in more stable and robust key population size estimates [5,11].

We used CRC to estimate the sizes of key populations in Kampala, Uganda, in June and October 2017.

Methods

Capture-Recapture

The CRC methodology is described in detail elsewhere [11,13,18-20]. Briefly, 4 main assumptions must hold for CRC to produce accurate population estimates: the population is closed; individual captures are independent; the capture history of each target population member is accurate; and the probability of being captured is homogenous [21]. The degree to which these assumptions are violated determine the accuracy of CRC-based population size estimates.

We defined MSM as men, aged 18 years or above, who self-identified as MSM. We defined FSW as women, aged 15 years or above, who reported currently selling sex for money. We defined PWID as people, aged 15 years or above, who reported currently injecting nonprescription or illegal drugs.

Local community-based organizations were consulted to discuss the selected objects (tags) and recommend peer distributors for each target population. Selected objects had no monetary value, were unique (ie, unavailable in Uganda), and differed according to each population. Different objects were used for each capture. Objects were procured in different colors with each color assigned for distribution in a different Division for quality assurance and to get a crude sense of mobility of objects across Kampala. Objects included keychains with bottle openers and lights, bracelets, and compact mirrors with unique phrases or artwork.

Data from mapping exercises and previous FSW and MSM size estimation conducted in 2011 and 2012 in Kampala were used to generate a range of the number of objects to be distributed in each of the 5 administrative Divisions of Kampala. As the PWID population had no prior population estimates, we utilized data from a nongovernmental organization, Community Health Alliance Uganda, that provided an estimated number of PWID hotspots per Division.

Data Collection

Peer staff were assigned to a particular Division in Kampala and within that Division, to a set of parishes (there were a total of 99 parishes in Kampala). Each parish had only 1 distributor per capture. A total of 2 peer FSW and MSM distributors were assigned to each of the 5 Divisions, whereas 1 PWID distributor was assigned to each Division. To facilitate independence between captures, new MSM and FSW distributors were selected for each capture stage. For PWID, the distributors remained the same, but were rotated and assigned to a new Division. Peer

distributors were asked to visit their assigned parishes and to distribute unique objects in areas where the population members work (FSW) or congregate (MSM and PWID). This included public spaces such as streets, bars, clubs, restaurants, and brothels.

Data collection for PWID and MSM CRC was conducted during June 2017 and during October 2017 for FSW. Each capture was set one week apart to minimize the effect of migration in and out of Kampala. All data were collected using ODK Collect on Android smartphones [22]. When a distributor encountered a likely member of the target population, they verified that the individual (1) was a member of the target population and (2) had not been previously approached by another distributor (in a different Division or parish that same week). Target population members were instructed to keep the unique objects with them for the next 2 weeks and not to give it away. Distributors recorded whether the target population member accepted or rejected an object, estimated the age group (15 to 17 years, 18 to 24 years, or >25 years), and documented the global positioning system (GPS) point of the encounter. MSM who appeared to be under the age of 18 years were not approached. No personal identifiers were collected and no compensation was provided. All questions in the ODK Collect program were contingent on the previous question being recorded to limit missing information. Per the protocol, women in the target population who were estimated to be under 18 years of age were referred for specialized support services.

During captures 2 and 3, members of the target population were asked to produce all of the objects they had received. If the approached population member claimed to have received one, but did not have the object with them, they were asked to identify the correct object from a piece of paper with pictures of 10 to 15 different objects (some similar to the real objects, some very different). Distributors recorded the picture the individual identified, but did not reveal whether they were correct or not. Target population members could have received no object, the capture 1 object, the capture 2 object, or both capture 1 and 2 objects. We defined a recapture as an individual who presented the object or was able to identify the correct object from a set of pictures.

Statistical Analysis

We calculated 3-source CRC (3SCRC) size estimates for all populations and when unable to calculate a 3SCRC, a 2-source CRC (2SCRC) size estimate was calculated in its place. We summarized 2-source capture histories into a 2x2 contingency table where the rows and columns represent the 2 capture occasions. Population size (N) for this group was calculated using the Lincoln-Petersen estimator assuming independence as follows [23]:

$$\hat{N} = M_1 * M_2 / R$$

where \hat{N} = estimated population size

M_1 = number of individuals recorded in first capture

M_2 = number of individuals recorded in second capture

R = number of individuals recorded in both captures

As the population size distribution was skewed and violated the normality assumption, we calculated a bootstrap 95% confidence interval for \hat{N} by resampling capture 2 data, 10,000 times (with replacement).

Furthermore, 3SCRC data were aggregated by captures into $2^k - 1$ observed frequencies, where k represents the number of captures ($k=3$). Each capture is listed as either 1 or 0 representing whether individuals are *captured* or *not captured*, respectively. Population sizes and 95% credible intervals (CI) were estimated using a Bayesian approach.

Latent-Class Bayesian Nonparametric Model

Consider the Kampala FSW and MSM populations to each be a closed finite population of N individuals. We conducted 3 capture stages for each population. Let $x_i = (x_{i1}, x_{i2}, x_{i3})$, with $x_{ik} = 1$ if the i^{th} individual was captured in the k^{th} FSW capture stage and 0 otherwise. Thus, $x_{i,j}, i=1, \dots, N$, represents the complete capture history of each individual in the FSW population (similarly for the MSM population). However, of the N individuals in the population, we are only able to capture $n < N$, where any individual with a capture history equal to (0,0,0) is unobserved. The total number of unobserved individuals is $n_0 = N - n$, the number to be estimated. Hence, 3SCRC estimation of the size of a closed population is essentially a missing data problem.

Following Little and Rubin [24], we can use a Bayesian approach to model the mechanism that leads to missing data and then to estimate the number of missing individuals. When there is heterogeneity of capture probabilities among individuals, this modeling is complicated as the heterogeneity induces dependency among capture stages. A mixture model approach is one technique used in CRC to account for individual heterogeneity [25]. Our choice of mixture model is the latent-class Bayesian nonparametric model of Dunson and Xing [26]. This choice of model avoids the model selection problem of choosing an appropriate number of latent classes, K , in advance [26].

The latent-class Bayesian nonparametric model accommodates various forms of capture probabilities and implements an automatic model selection procedure [27]. Uninformative priors, that is, those that have minimal influence on the inference and dominated by the likelihood function, were specified for the Dirichlet process parameter ($\alpha \sim \text{Gamma}(0.25, 0.25)$) as suggested in the literature [28]. We used $K=10$ latent classes; 150,000 samples from the posterior distribution were drawn with a burn-in of 10,000 iterations and a thinning interval of 100 iterations to specify the MCMC sampling.

We performed a sensitivity analysis to investigate the robustness of the posterior distribution of N to a range of priors for α . Smaller values favor sparse mixtures, whereas large values favor a more complex joint distribution. Convergence of the Markov Chain Monte Carlo sampling was assessed using trace plots and by setting various burn-in periods. Statistical analysis was performed in R (version 3.4.2) [29] and the Bayesian nonparametric latent-class capture-recapture package (LCMCR);

sample R code for LCMCR analysis is available in [Multimedia Appendix 1](#) [30].

The study protocol was approved by the human subjects protection board at Makerere University School of Public Health and the Centers for Disease Control and Prevention (CDC).

Results

Sampling

People Who Inject Drugs

Individuals accepted 467 bracelets and refused 5 during capture 1. Individuals accepted 450 bracelets and refused 18 during capture 2. In total, 54 PWID were captured in both capture 1 and 2 (Figure 1). During capture 3, distributors approached and asked 475 PWID to present/identify the object(s); however, recording errors prevented the use of capture 3 data (Figure 1).

Men Who Have Sex With Men

Individuals accepted 542 keychains and refused 52 during capture 1. Individuals accepted 574 keychains and refused 26 during capture 2. During capture 3, distributors approached and

asked 598 MSM to present/identify the object(s). There were 70 captured in captures 1 and 2, 103 captured in captures 2 and 3, and 155 captured in captures 1 and 3. There were 57 MSM captured in all 3 captures.

Female Sex Workers

Individuals accepted 962 mirrors and refused 77 during capture 1. Individuals accepted 965 mirrors and refused 41 during capture 2. During capture 3, distributors approached and asked 1417 FSW to present/identify the object(s). There were 316 captured in captures 1 and 2, 214 captured in captures 2 and 3, and 235 captured in captures 1 and 3. There were 109 FSW captured in all 3 captures.

We estimated the number of PWID to be 3892 (95% confidence interval: 3090-5126) using 2SCRC (Table 1). We estimated the population of MSM in Kampala to be 14,019 (95% CI 4995-40,949) and the number of FSW to be 8848 (95% CI 6337-17,470) using the Bayesian approach to 3SCRC. Sensitivity analyses results for the MSM and FSW estimates showed no substantial difference between the estimates as can be seen from the overlapping 95% CI (Figure 2).

Figure 1. Capture history diagrams for people who inject drugs (PWID), men who have sex with men (MSM), and female sex workers (FSW), Kampala, Uganda, 2017.

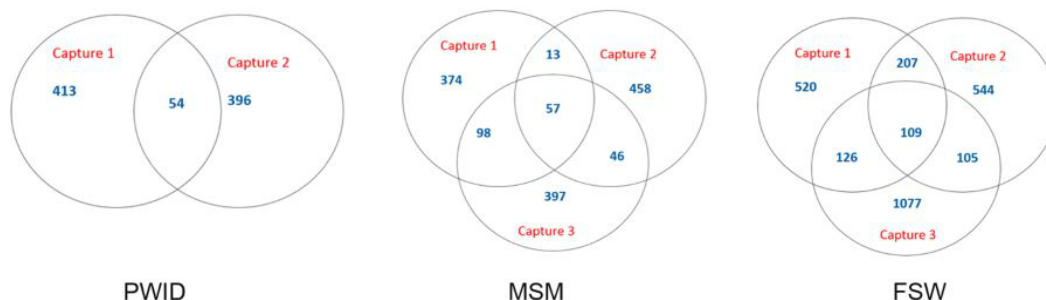


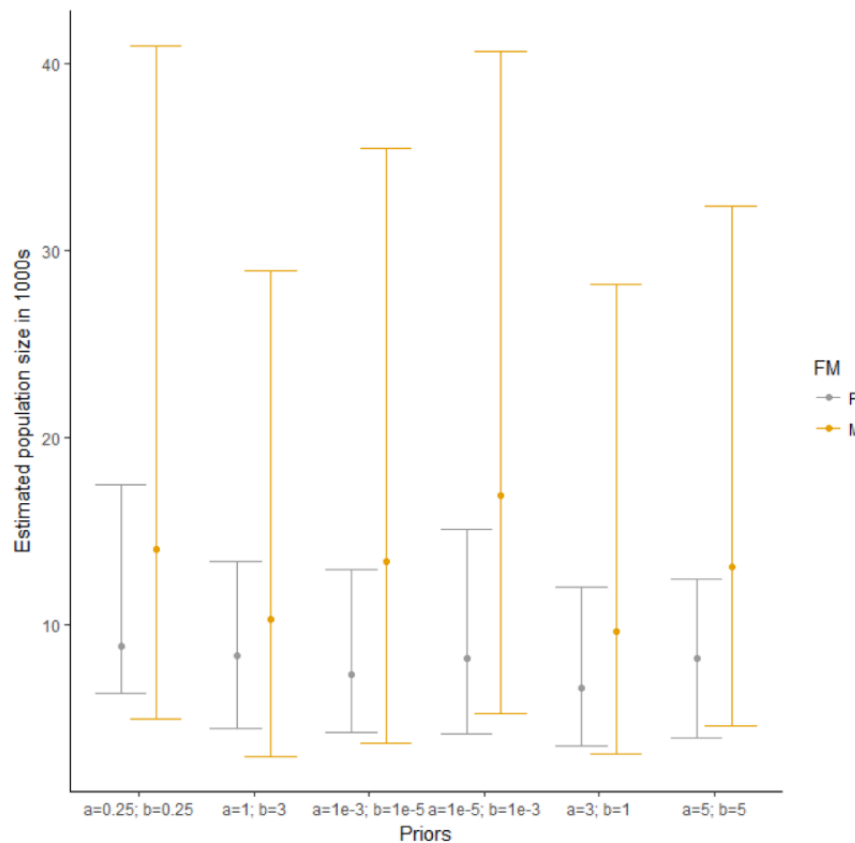
Table 1. Population size estimates for people who inject drugs, men who have sex with men, and female sex workers, Kampala, Uganda, 2017.

Population ^a	Estimates (95% confidence interval) ^b
People who inject drugs	3892 (3090-5126)
Men who have sex with men	14,019 (4995-40,949)
Female sex workers	8848 (6337-17,470)

^aPopulation of people who inject drugs was estimated using 2-source capture-recapture; populations of men who have sex with men and female sex workers were estimated using 3-source capture-recapture with the Bayesian nonparametric latent-class capture-recapture (LCMCR) package.

^b95% confidence interval for people who inject drugs and 95% credible interval for men who have sex with men and female sex workers.

Figure 2. Three-source capture-recapture sensitivity analysis comparing the median and 95% credible intervals of the population size for men who have sex with men and female sex workers, Kampala, Uganda, 2017. Error bars denote the lower and upper bounds of the 95% credible intervals, whereas the filled circles indicate the median. F: female; M: male.



Discussion

These population size estimates represent the first use of 3SCRC for FSW and MSM and the first use of 2SCRC for PWID in Kampala, Uganda.

Our 2SCRC PWID estimate of 3892 (95% confidence interval: 3090-5126) is substantially higher than previous estimates (10 PWID per 100,000 people or 70 to 80 PWID total) which were based on clinic data and counts at hotspots [10]. Although we were unable to use data from a third capture of PWID because of data collection errors, our 2-source estimate suggests that injection drug use may be more prevalent than originally expected [10].

We compared our MSM and FSW results with the population size estimates from 2012. Our MSM estimate (14,019) is higher than the 2012 estimate of 7900 (report by The Crane Survey, 2012). Our crude Kampala MSM estimate represents approximately 4% of the adult male population (aged 18 years or above) in Kampala [31]. Factors influencing our MSM population size estimate might reflect long-term migration patterns among MSM, both rural to urban, as well as migration from smaller to larger urban settings [32,33]. To some extent, MSM size estimates are also determined by the proportion of gay men who may or may not practice their same sex sexuality, a potentially large factor given the highly stigmatized climate in Uganda and its accompanying social norms (marriage and having children). Global estimates suggest that MSM represent

3% to 5% of the general population (ie, before taking migration patterns into account) and can be higher depending on the region [34]. To the extent that rural gay men may be more likely to migrate to urban settings compared with rural heterosexual men, we can expect correspondingly larger proportions of adult urban MSM. Furthermore, Kampala and other urban settings are rapidly growing in total general population size; hence, we can expect the use of equal proportional estimates in 2012 and 2017 to lead to higher absolute estimates in 2017.

The FSW result (8848) is lower than the 2012 estimate of 13,200 (report by The Crane Survey, 2012). Our FSW estimate represents approximately 2% of the Kampala adult female population (aged 15 years and above) [31]. Global FSW population size estimates differ depending upon the sampling method and location. In sub-Saharan African FSW estimates generally fall within 0.7% to 4.3% of the adult female population [35].

Both the MSM and FSW 2012 estimates fall within our 95% CI; however, the CRC methods reported here differ from the previous round of population size estimation for MSM and FSW. Although both employed CRC methodology, the previous estimates used respondent-driven sampling (RDS) surveys as capture 2. There was a difference of 9 to 12 months between captures, compared with only a week for our study. A longer period between captures allows for more in- and out-migration (to and from Kampala), violating one of the four assumptions. As a result, fewer recaptures can be expected, resulting in an inflated size estimate.

There were a number of limitations to the design of the estimation activity. Possible violations of the underlying CRC assumptions could influence the validity of our outcomes and may have resulted in inaccurate population sizes and wider confidence intervals. First, we used unique objects as a tagging mechanism to maintain the anonymity of sampled populations. However, not all individuals were carrying the unique object during subsequent captures, complicating the identification of recaptures. In addition, we must assume that the person presenting the object is the person who received the object (an inherent limitation present in anonymous sampling-based CRC). We tried to mitigate the bias involved in tagging individuals with objects by offering individuals the opportunity to identify the objects from a set of pictures, in addition to reducing the time between captures to 1 week. The short time between each capture also gave us more confidence in the assumption of a closed population. Although we recognize that these populations are mobile, there was likely little change over a 1-week period.

To minimize dependencies between captures, we used different distributors for each capture. Nevertheless, the capture probabilities were likely heterogeneous and target population members tagged in capture 1 may have been more likely to be tagged in captures 2 and 3. This is especially true for MSM and PWID, where we collected captures at known MSM- or PWID-friendly venues. Individuals with higher social visibility are more likely captured at these known sites. Individuals with higher social visibility are more likely to be captured, thus our results are likely to be underestimates for all populations. One way to capture individuals with lower social visibility would be to use an RDS survey as the third capture; however, the target sample size would need to be achieved quickly to mitigate in- and out-migration. In addition, one might expand captures to various other data sources (not just object distribution) to include service lists, social media or other Web-based sites to reach those who might not attend venues.

Our final estimates were based on a Bayesian approach to accommodate the complex patterns of heterogeneity between captures and aggregation of homogenous strata into latent classes, whereas other statistical approaches make reasonably strong assumptions about the structure of the joint distribution of capture patterns [27]. In contrast, the latent-class Bayesian approach is a model-averaging technique and attempts to estimate the joint distribution directly from the data as much as possible [27]. Our use of the LCMCR method to estimate the size of hard-to-reach human population is innovative as the

approach is not originally developed for analyzing epidemiological data such as those obtained from in-person listing of key populations. The unique individual characteristic of these populations contributes to most of the dependence between capture histories; therefore, the nonparametric latent-class model implemented in LCMCR is reasonable to use.

Working with each of the key populations brought on unique challenges and could have resulted in biased population size estimates. Our definition of each key population was sensitive and it is possible that nontarget population members were counted in each capture. We had substantial challenges finding and training MSM for this activity. In addition, the refusal rate for the unique object among MSM was higher than among the other 2 populations who rarely refused the object (8.8% of MSM compared with 1.2% for FSW and 1.0% for PWID). Furthermore, we found at least one problematic distributor in each target population, which may have biased our results. For example, in capture 3, one particular PWID distributor sampled 54 PWID (all found in the same Division) who had received both objects distributed in capture 1 and 2. Allegedly, all 54 PWID had the exact same color objects. As investigators knew which color had been distributed in each Division (a quality assurance mechanism), and the recorded color of the object had been distributed in another Division, it became clear that the data had very likely been fabricated; hence, we decided to exclude capture 3. There were also anecdotal observations of target population members approaching the distributor hoping to get an object, especially among the FSW population. This suggested that the objects may not always have been given out at random and the members of the target populations did not necessarily have an equal chance of being tagged. Increased monitoring and supervisor would likely help mitigate some of these challenges. One of the benefits of using 3SCRC is the ability to partially account for such dependencies by allowing sources to be examined pairwise (interactions) [13].

In conclusion, we generated new size estimates for key populations in Kampala and demonstrated that 3SCRC is a feasible size estimation method. These estimates will provide critical denominators that may serve as a basis for HIV prevention and treatment program planning by HIV coordinating bodies in Uganda. As we move closer to HIV epidemic control, estimating the size of these key populations will be important to examine and document progress.

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Authors' Contributions

All authors substantially contributed to the study's design, conduct, or to data analysis and interpretation and wrote or edited parts of the paper and approved the final version for publication.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Sample R code for LCMCR analysis.

[PDF File (Adobe PDF File)41 KB - [publichealth_v5i3e12118_app1.pdf](#)]

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Abbreviations

2SCRC: 2-source capture-recapture

3SCRC: 3-source capture-recapture

CDC: Centers for Disease Control and Prevention

CI: credible interval

CRC: capture-recapture

FSW: female sex workers

LCMCR: Bayesian nonparametric latent-class capture-recapture package

MSM: men who have sex with men

PWID: people who inject drugs

RDS: respondent-driven sampling

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Original Paper

Noncommunicable Disease Emergencies During Arbaeenia Mass Gathering at Public Hospitals in Karbala, Najaf, and Babel Governorates, Iraq, 2014: Cross-Sectional Study

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Abstract

Background: Arbaeenia is the largest religious mass gathering (MG) in Iraq where millions of people from Iraq and many other countries visit Karbala city, south Iraq. MGs are associated with high rates of morbidity and mortality from different noncommunicable diseases (NCDs) such as cardiovascular diseases, diabetes mellitus, and asthma. There is a scarcity of publications that address MGs in Iraq.

Objective: This study aimed to explore the NCD emergencies in public hospitals in Karbala, Najaf, and Babel governorates in Iraq, during the Arbaeenia MG and assess predisposing factors for NCD emergencies.

Methods: The study was conducted from November 27 to December 16, 2014. Data were collected in the pre-event and during MG event from 7 selected hospitals. The pre-event data were collected from emergency room (ER) registers and logbooks, and the data on the MG event were collected daily through direct interview with patients and treating physicians using a structured questionnaire.

Results: In total, 4425 NCD emergencies were recorded. Of these, 80.13% (3546/4425) were collected during the MG event. The NCD emergencies attended at ER hospitals during MG were severe hypertension (HT), diabetes (hyperglycemia), ischemic heart disease (IHD), asthma, and pulmonary edema. The load of NCD emergencies and the daily average emergencies increased 4-fold and 2-fold during the MG event, respectively. Most of the NCD emergencies were treated at ER departments, and a few were hospitalized. Intense physical activities and poor adherence to diet and medication were risk factors for IHD, severe HT, and hyperglycemic diabetes emergencies. Exposure to noxious gases or fumes and recent respiratory infections were risk factors for asthma emergencies.

Conclusions: As the pilgrims approached Karbala city during the Arbaeenia MG, the hospitals on the roads leading to the city experienced an increased load of patients because of different NCD emergencies. Although hospitals should be equipped with the necessary supplies, health education for pilgrims is mandatory, particularly on the factors that can exacerbate their diseases.

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KEYWORDS

mass gathering; Iraq; noncommunicable diseases

Introduction

Background

The World Health Organization defines mass gatherings (MGs) as “events attended by a sufficient number of people to strain the planning and response resources of a community, state or nation” [1]. MGs carry potential health risks to the local population and to the global community [2-4]. Such gatherings pose a significant public health threat to the host country and the attendees’ countries of origin [2,3,5-8]. The nature of MGs can be political rallies, social events, religious activities, sporting events, and others [5]. Organizers of most MGs, especially those of a longer duration such as the Hajj, Olympics, or the Kumbh Mela in India, offer basic health services to the attendees [9,10]. Individuals attending the MGs and the host population are at risk of communicable disease infections, injuries, and exacerbations of noncommunicable diseases (NCDs). MGs have been associated with high rates of morbidity and mortality from NCDs, accidents, and terrorist attacks [11].

During the Hajj MG, high rates of morbidity and mortality from NCDs, such as cardiovascular diseases, diabetes mellitus (DM), and asthma were reported [2,3,12-14,15-17]. Attendees traveling to the event from outside the country may be exposed to a different environment in addition to altering their daily routine and diets [18,19]. Walking long distances, changes in daily activities, and poor adherence to diet and medications could negatively impact NCD control, particularly hypertension (HT), DM, and ischemic heart diseases (IHDs) [18]. The incidence of severe acute cardiovascular events is more than doubled during MGs for people exposed to intense stress [2,20,21].

In Iraq, religious MGs occur throughout the year, mainly in Karbala, Najaf, and Baghdad. Arbaeenia is the largest religious MG and convenes in Karbala annually [5]. During Arbaeenia, Shi’a Muslims commemorate the 40 days following the day of the martyrdom of Hussein bin Ali, the grandson of the Prophet Muhammad, at the Battle of Karbala in 61 AH (680 CE) [5].

More than 10 million people, mainly from Iraq, visit Imam Hussein’s shrine in Karbala. Attendees walk hundreds of kilometers for many days to reach Karbala. These visitors are exposed to risks that could affect their health including intense physical activity and poor adherence to diet regimes and medications. The Arbaeenia MG follows the Islamic lunar calendar, and the date moves forward by 10 to 11 days every year, therefore presenting health risks associated with seasonal variation [5,22].

Objectives

The public health impact of religious MGs in Iraq has rarely been studied [5]. This study aimed to describe NCD emergencies during the Arbaeenia MG and to assess predisposing factors for NCD emergencies.

Methods

Setting and Data Collection

The study was conducted from November 27 to December 16, 2014, in 3 Iraqi governorates: Karbala, Najaf, and Babel, located

to the south of Baghdad, with a population of over a million each. We implemented the study in two phases, the pre-event phase that covered the first 7 days of the survey and the event phase covering 13 days, during their journey to the event. The pre-event phase serves as a baseline for NCD emergencies and admissions; the event phase captures the burden of NCDs during the MG.

Data on all patients attended for NCD diagnoses at emergency rooms (ERs) or admitted to 1 of the 7 hospitals selected for the study were collected. The selected hospitals included the 4 main Ministry of Health (MOH) hospitals located at the center of selected governorates and 3 small hospitals located along the road to Karbala. A total of 3 of the selected hospitals (Al-Seder, Al-Hakeem, and Al-Haideria) were located in Najaf, 3 in Babel (Hashmia, Al-Qasim, and Merjan), and 1 in Karbala (Al-Hussein Hospital).

NCD emergencies include the following 6 groups: HT or hypotension; DM: hypoglycemia, ketoacidosis, and hyperosmolar syndrome; IHD: angina pectoris, myocardial infarction (MI), arrhythmias; cerebrovascular accident (CVA): ischemic and hemorrhagic accidents; chronic obstructive pulmonary disease (COPD): asthma and other intermittent, persistent COPDs; and cardiogenic pulmonary edema (PE): heart failure owing to IHDs.

Data on the pre-event phase were collected by a team of 6 Field Epidemiology Training Program graduates and current officers led by the principal investigator. Data were abstracted from available registers and logbooks of the 7 selected hospitals in the pre-event phase. During the event phase, data were collected daily (24 hours) by direct interview with patients or accompanying relatives and treating physicians using a questionnaire, which was filled by trained health personnel.

Data Variables

The information collected included age, sex, residence, provisional diagnosis obtained from treating physicians, and potential predisposing factors that might have led to development of the NCD emergency, which included intense physical activity, poor adherence to dietary regimen, poor adherence to medications, exposure to noxious gases or fumes, and history of recent respiratory infection (RI).

Statistical Analysis

Epi Info developed by US Center of Diseases Control and Prevention, Atlanta, Georgia and SPSS acquired by IBM were used for data entry and analysis. We estimated the daily average number of patients with NCDs attending the ER by study phase and tested the differences between the daily average patients in the pre-event and event study phase by demographics and by hospitals or departments. We used a *t* test to test statistical differences at $P < .05$. We estimated the risk ratio (RR) and 95% CIs of predisposing factors for NCD emergencies.

Official approval was obtained from the Iraqi MOH before implementation of the study. Confidentiality of data throughout the study was assured, and access to data was limited to research team members.

Results

Tables 1 and 2 show the number and daily average for NCD emergencies by demographics and hospitals and by study phase. There were 4425 NCD patients reported in the study period, of which 80.13% (3546/4425) were reported during the event phase, a 4-fold increase. The hospitals attended 211 patients on average per day. The daily average number of patients was more than 2-fold during the event phase compared with the pre-event, 273 and 126 cases, respectively, $P < .001$. The significant differences in the daily average number of NCD emergencies between the pre-event and event phase remained significant across age groups, gender, and residence ($P < .001$).

The majority of patients (76.43%, 3382/4425) were aged 40 years and older and 5.11% (226/4425) were younger than 20 years. The male and female ratio was 1.2:1. A larger number of males were observed during the event phase, whereas a similar ratio of both sexes was observed in the pre-event phase. Almost three-quarter of the cases was residents of the 3 governorates: Najaf, Babel, and Karbala. About 10.32% (457/4425) were foreigners.

Karbala attended the highest number of NCD emergencies (37.45%, 1657/4425) reported by the single participating hospital in the study, and Babel reported the least (26.31%, 1164/4425). The daily average of NCD emergencies between the pre-event and event differed significantly in Najaf ($P = .006$), Karbala ($P < .001$), and Babel ($P = .03$). The largest daily average number of NCD emergencies were attended in Al-Hussein hospital in Karbala, 83 cases, whereas Al-Qasem hospital attended the least, 9 cases. Both Al-Hussein and Al-Qasem hospitals attended 3.44% (1657/4425) and 3.93% (174/4425) of the total cases, respectively (Table 2). The daily average number of NCD emergencies between the pre-event and event study phases differ significantly in Al-Hussein ($P < .001$) and Al-Haideria hospitals ($P = .008$).

The majority (91.71%, 4058/4425) of NCD emergencies were attended at the ER, and 8.29% (367/4425) were hospitalized. Daily admissions to hospitals did not vary by study phase and remained at around 18 patients per day. In contrast, the average daily cases attended at the ERs increased from 107 patients in the pre-event to 254 patients in the event phase ($P < .001$).

Table 1. Distribution of number and daily average of noncommunicable disease emergencies by demographics and study phase, Iraq 2014.

Demographics	Pre-event		Event		Total		P value ^a
	n (%)	Daily average	n (%)	Daily average	n (%)	Daily average	
Age group (years)							
<20	54 (6.1)	8	172 (4.85)	13	226 (5.11)	11	.02
20-39	162 (18.4)	23	655 (18.47)	50	817 (18.46)	41	<.001
40-49	339 (38.6)	48	1411 (39.79)	109	1750 (39.55)	88	<.001
≥60	324 (36.9)	46	1308 (36.89)	101	1632 (36.88)	82	<.001
Sex							
Male	443 (50.4)	63	1960 (55.27)	151	2403 (54.31)	120	<.001
Female	436 (49.6)	62	1586 (44.73)	122	2022 (45.69)	101	<.001
Residence							
Karbala-Najaf-Babel	794 (90.3)	113	2437 (68.73)	187	3231 (73.02)	162	<.001
Other Iraq Governorates	59 (6.7)	8	678 (19.12)	52	737 (16.65)	37	<.001
Foreign countries	26 (2.9)	4	431 (12.15)	33	457 (10.33)	23	<.001
Reporting governorates							
Najaf	358 (40.7)	51	1246 (35.14)	96	1604 (36.25)	80	.006
Karbala	198 (22.5)	28	1459 (41.14)	112	1657 (37.45)	83	<.001
Babel	323 (36.8)	46	841 (23.72)	65	1164 (26.30)	58	.03
Total	879 (100.0)	126	3546 (100.00)	273	4425 (100.00)	221	<.001

^aP value (*t* test) testing differences between daily average in the pre-event and event study phase.

Table 2. Distribution of number and daily average of noncommunicable disease emergencies by hospitals and study phase, Iraq 2014.

Hospitals	Pre-event		Event		Total		P value ^a
	n (%)	Daily average	n (%)	Daily average	n (%)	Daily average	
Hospital							
Al Haideria	34 (3.9)	5	504 (14.21)	39	538 (12.15)	27	.008
Al Hakeem	216 (24.6)	31	513 (14.46)	39	729 (16.47)	36	.42
Al Hashmia	102 (11.6)	15	377 (10.63)	29	479 (10.82)	24	.06
Al Hussien	198 (22.5)	28	1459 (41.14)	112	1657 (37.44)	83	<.001
Al Qasim	47 (5.4)	7	127 (3.58)	10	174 (3.93)	9	.28
Al Seder	108 (12.3)	15	229 (6.45)	18	337 (7.61)	17	.59
Merjan	174 (19.8)	25	337 (9.50)	26	511 (11.54)	26	.85
Total	879 (100.0)	126	3546 (100.00)	273	4425 (100.00)	221	<.001
Hospital department							
Emergency room	751 (85.4)	107	3307 (93.26)	254	4058 (91.70)	203	<.001
Admissions	128 (14.6)	18	239 (6.73)	18	367 (8.29)	18	.98
Total	879 (100.0)	126	3546 (100.00)	273	4425 (100.00)	221	<.001

^aP value (*t* test) testing differences between daily average in the pre-event and event study phase.

Table 3 shows the percent distribution and the daily average of types of NCD emergencies during the pre-event and event phases. Among the reported NCD emergencies, blood pressure-related emergencies (hypotension or HT) were the most frequently encountered (36.04%, 1595/4425), of which 29.04% (1285/4425) was severe HT and 7.00% (310/4425) low blood pressure. IHDs were the second highest reported NCD emergencies (21.10%, 934/4425), of which angina pectoris constituted 11.77% (521/4425), arrhythmias 5.49% (243/4425), and MI 3.84% (170/4425). Around 19.23% (851/4425) of NCD emergencies were asthma, and 16.43% (727/4425) were DM, of which hyperglycemia with and without ketoacidosis accounted for 1.78% (654/4425) of all reported emergencies, and hypoglycemic emergencies were less than 2% (1.64%, 73/4425) of all cases. PE and CVAs were the least reported emergencies, 4.00% (177/4425) and 3.16% (140/4425), respectively. The daily average number of patients in the pre-event and event phase varied significantly in IHDs, DM, hypotension or HT, asthma, and PE, $P < .05$.

Table 4 shows the number and percent distribution of predisposing factors to the NCD emergencies. Of the cases who had intense physical activity, 52.1% (321/616) experienced IHD, 4.9% (30/616) experienced severe HT, 0.8% (5/616) experienced hyperglycemia, 12.3% (76/616) experienced asthma, 3.1% (19/616) experienced PE, and 1.8% (11/616) experienced CVA. Of those who reported poor adherence to diet, 22.5% (211/936) had IHD, 36.5% (342/936) had severe HT, 27.9% (261/936) had hyperglycemia, 2.3% (22/936) had asthma, and PE and CVA had around 1% each. For those who reported poor adherence to medication, 17.07% (241/1412) had

IHD, 44.05% (622/1412) had severe HT, 20.89% (295/1412) had hyperglycemia, 10.69% (151/1412) had asthma, 5.24% (74/1412) had PE, and 1.48% (21/1412) had CVA. Of those exposed to noxious gases, 94.9% (111/117) reported asthma and 5.1% (6/117) reported PE. In addition, of the cases who had a history of recent RI, 92.8% (271/292) reported asthma and 3.4% (10/292) reported PE.

Table 5 shows the risk ratio of predisposing factors for NCD emergencies. Patients who reported intense physical activity were more likely to have IHD emergencies (RR=3.1, 95% CI 2.8-3.5) and less likely to have severe HT (RR=0.14, 95% CI 0.1-0.2), hyperglycemia (RR=0.04, 95% CI, 0.02-0.1), and asthma emergencies (RR=0.6, 95% CI 0.5-0.8) compared with those who did not report intense physical activity. Patients who reported poor adherence to diet were more likely to have severe HT (RR=1.4, 95% CI 1.2-1.5) and hyperglycemia (RR=2.3, 95% CI 1.9-2.6) and less likely to have asthma (RR=0.1, 95% CI 0.06-0.1) and PE emergencies (RR=0.1, 95% CI 0.05-0.3) compared with patients who did not report poor adherence to diet. Patients with poor adherence to medications were more likely to have higher severe HT (RR=2.3, 95% CI 2.1-2.6), hyperglycemia (RR=1.5, 95% CI 1.3-1.8), asthma (RR=1.4, 95% CI 1.2-1.7), and PE emergencies (RR=2.6, 95% CI 1.8-3.8) and less likely to have IHD emergencies compared with those who did not report poor adherence to medication. Patients who had exposure to noxious gases had higher risk for asthma (RR=5.9, 95% CI 5.4-6.5) compared with those who did not report exposure. Similarly, patients who had a history of recent RI had higher risk for asthma (RR=7.9, 95% CI 7.2-8.8) compared with those who did not report a history of recent RI.

Table 3. Distribution of number and daily average of noncommunicable disease emergencies by study phase.

NCD ^a emergencies	Pre-event		Event		Total		P value ^b
	n (%)	Daily average	n (%)	Daily average	n (%)	Daily average	
Ischemic heart disease	199 (22.7)	28	735 (20.72)	57	934 (21.11)	47	<.001
Angina	104 (11.9)	15	417 (11.75)	32	521 (11.77)	26	.006
Arrhythmias	61 (6.9)	9	182 (5.13)	14	243 (5.49)	12	.07
Myocardial infarction	34 (3.9)	5	136 (3.83)	10	170 (3.84)	9	<.001
Hypotension/ hypertension	296 (33.7)	42	1299 (36.63)	100	1595 (36.05)	80	<.001
Severe hypertension	223 (25.4)	32	1062 (29.94)	82	1285 (29.04)	64	<.001
Hypotension	73 (8.3)	10	237 (6.68)	18	310 (7.00)	16	.03
Diabetes mellitus	124 (14.1)	18	603 (17.00)	46	727 (16.43)	36	<.001
Hyperglycemia	112 (12.8)	16	542 (15.28)	42	654 (14.78)	33	<.001
Hypoglycemia	12 (1.4)	2	61 (1.72)	5	73 (1.65)	4	.01
Asthma	166 (18.9)	24	685 (19.31)	53	851 (19.23)	43	<.001
Pulmonary edema	40 (4.6)	6	137 (3.86)	11	177 (4.00)	9	.02
Cerebrovascular accidents	53 (6.0)	8	87 (2.45)	7	140 (3.16)	7	.60
Total	878 (100.0)	125	3546 (100.00)	273	4424 (100.00)	221	<.001

^aNCD: noncommunicable disease.

^bP value is based on the *t* test.

Table 4. Number of noncommunicable disease emergencies by predisposing factors.

Noncommunicable disease emergency	Potential predisposing factors, n (%)					Total responses
	Intense physical activity	Poor adherence to diet	Poor adherence medications	Exposure to noxious gases	History of exposure to recent respiratory infection	
Ischemic heart disease	321 (52.1)	211 (22.5)	241 (17.06)	0 (0.0)	8 (2.7)	781 (23.15)
Angina	173 (28.0)	124 (13.2)	138 (9.77)	0 (0.0)	6 (2.0)	441 (13.07)
Arrhythmias	81 (13.1)	54 (5.7)	48 (3.39)	0 (0.0)	0 (0.0)	183 (5.42)
Myocardial infarction	67 (10.8)	33 (3.5)	55 (3.85)	0 (0.0)	2 (0.6)	157 (4.65)
Hypotension/hypertension	151 (24.5)	407 (43.4)	628 (44.47)	0 (0.0)	2 (0.6)	1188 (35.22)
Severe Hypertension	30 (4.8)	342 (36.5)	622 (44.05)	0 (0.0)	1 (0.3)	995 (29.49)
Hypotension	121 (19.6)	65 (6.9)	6 (0.42)	0 (0.0)	1 (0.3)	193 (5.72)
Diabetes mellitus	38 (6.1)	278 (29.7)	297 (21.03)	0 (0.0)	1 (0.3)	614 (18.20)
Hyperglycemia	5 (0.8)	261 (27.8)	295 (20.89)	0 (0.0)	1 (0.3)	562 (16.66)
Hypoglycemia	33 (5.3)	17 (1.8)	2 (0.14)	0 (0.0)	0 (0.0)	52 (1.54)
Asthma	76 (12.3)	22 (2.3)	151 (10.69)	111 (94.8)	271 (92.8)	631 (18.70)
Pulmonary edema	19 (3.0)	5 (0.5)	74 (5.24)	6 (5.1)	10 (3.4)	114 (3.37)
Cerebrovascular accidents	11 (1.7)	13 (1.3)	21 (1.48)	0 (0.0)	0 (0.0)	45 (1.33)
Total responses	616 (100.0)	936 (100.0)	1412 (100.00)	117 (100.0)	292 (100.0)	3373 (100.00)

Table 5. Risk ratio of predisposing factors for noncommunicable disease emergencies.

Potential risk factors	Risk ratio (95% CI)					
	Ischemic heart diseases	Severe hypertension	Diabetes mellitus (hyperglycemia)	Asthma	Pulmonary edema	Cerebrovascular accidents
Intense physical activity	3.1 (2.8-3.5)	0.14 (0.1-0.2)	0.04 (0.02-0.1)	0.6 (0.5-0.8)	0.9 (0.6-1.6)	1.4 (0.7-2.8)
Poor adherence to diet	1.0 (0.8-1.1)	1.4 (1.2-1.5)	2.3 (1.9-2.6)	0.1 (0.06-0.1)	0.1 (0.05-0.3)	1.1 (0.6-2.2)
Poor adherence to medications	0.6 (0.5-0.7)	2.3 (2.1-2.6)	1.5 (1.3-1.8)	1.4 (1.2-1.7)	2.6 (1.8-3.8)	1.2 (0.7-2.2)
Exposure to noxious gases	— ^a	—	—	5.9 (5.4-6.5)	1.5 (0.7-3.4)	—
History of exposure to recent respiratory infection	—	—	—	7.9 (7.2-8.8)	1.0 (0.5-1.9)	—

^aNot applicable.

Discussion

Principal Findings

This is the first study to describe NCD emergencies during MG events in Iraq. The most common emergencies attended in the hospitals during the event were HT, IHD, asthma, and diabetes (hyperglycemia). The load of the NCD emergencies during the MG event increased 4-fold, and the daily average cases also doubled compared with the pre-event. This indicates the immense burden of NCD emergencies to hospitals during MG events and the need for adequate planning of services by the government of Iraq. This is beyond the MOH capacity and domain and needs the participation of other ministries and governmental agencies.

The daily average for NCD emergencies increased 2-fold in IHD and asthma and almost 3-fold in severe HT and diabetes (hyperglycemia) during the event. These findings are consistent with other studies conducted in the region during religious MG events [5,13,14,23]. Severe HT and diabetes (hyperglycemia) are likely to be sensitive to changes in physical activity, diet and medications, which are disrupted during the MG.

The study shows that intensive physical activity leads to IHD emergency but is inversely correlated with severe HT and diabetic-hyperglycemia emergencies during the MG event. Regular exercise controls HT and diabetic hyperglycemia and improves IHD, but sudden physical activities in individuals with cardiovascular diseases might precipitate heart attack [17]. Poor adherence to diet and medications for hypertensive, diabetics, and asthmatic patients predispose to ER attendance for treatment in the MG event. Similarly, exposure to noxious gases or fumes, which is obvious in Iraq MG, and history of recent RI lead to ER attendance for asthma treatment. Individuals with NCDs should be accompanied by caring relatives, in addition to receiving regular checkups at mobile clinics to avoid medical emergencies and premature deaths.

The risk for medical emergencies and hospital admissions during MG are often related to the size of the masses, climatic conditions, demographics, services availability, prior planning, and behaviors of the attendees. The purpose of the MG studied

was religious, where masses march orderly, but the lack of prior planning for service needs, harsh climatic conditions, long distance walk, lack of adequate services, and overcrowding may have contributed to medical emergencies observed in the study. Setting up temporary resting places, mobile clinics, and maintaining sufficient supply of health care staff could minimize the need for ER medical services and hospitalizations, which could be addressed through proper planning and implementation.

Most of the NCD emergencies were handled in the ER departments and few were admitted to the hospitals, which is similar to a study conducted in Iraq during the Ashuraa religious MG [5]. The majority of the NCD cases were aged younger than 50 years and more likely to be healthy, which may have contributed to low hospitalizations.

Limitations

The study has some limitations. The increased load during the event phase was solely related to patients with NCD emergencies attending ER departments. Some NCD emergency cases may have been missed because of the chaotic conditions at the ER departments during the MG. Some patients attended in ER may have also been admitted to the hospitals after the data were collected, affecting the percent of admissions. As this study was confined to the hospitals, NCD emergency cases treated in mobile clinics were not counted; thus, the increase of cases in the event could be higher than the numbers reported. The study was limited to 7 hospitals, and the load of NCD emergencies attended in other hospitals may result in different estimates of the effect of MG on NCD emergencies.

Conclusions

In conclusion, with the pilgrims approaching their destination to Karbala city during Arbaenia MG, the hospitals on the roads leading to the city experienced an increased load of patients because of different NCD emergencies. Although the MOH is more concerned with outbreaks of communicable diseases during MGs, NCDs should be seriously considered in the MGs planning. The hospitals should be fully equipped with the necessary supplies and trained health workers. Furthermore, health education for pilgrims is mandatory, particularly on the factors that can exacerbate their diseases.

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Conflicts of Interest

None declared.

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Abbreviations

COPD: chronic obstructive pulmonary disease
CVA: cerebrovascular accident
DM: diabetes mellitus
ER: emergency room
HT: hypertension
IHD: ischemic heart disease
MG: mass gathering
MI: myocardial infarction
MOH: Ministry of Health
NCD: noncommunicable disease
PE: pulmonary edema
RI: respiratory infection
RR: risk ratio

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Original Paper

Assessment of Temporary Medical Clinics During the Arbaeenia Mass Gathering at Al-Karkh, Baghdad, Iraq, in 2014: Cross-Sectional Study

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Abstract

Background: During mass gatherings, public health services and other medical services should be planned to protect attendees and people living around the venue to minimize the risk of disease transmission. These services are essential components of adequate planning for mass gatherings. The Arbaeenia mass gathering signifies the remembrance of the death of Imam Hussain, celebrated by Shiite Muslims, and takes place in Karbala, which is a city in southern Iraq. This annual mass gathering is attended by millions of people from within and outside Iraq.

Objective: This study aimed to map the availability of medical supplies, equipment, and instruments and the health workforce at the temporary clinics located in Al-Karkh, Baghdad, Iraq, in 2014.

Methods: This assessment was conducted on the temporary clinics that served the masses walking from Baghdad to Karbala. These clinics were set up by governmental and nongovernmental organizations (NGOs) and some faith-based civil society organizations, locally known as mawakib. We developed a checklist to collect information on clinic location, affiliation, availability of safe water and electricity, health personnel, availability of basic medical equipment and instruments, drugs and other supplies, and average daily number of patients seen by the clinic.

Results: A total of 30 temporary clinics were assessed: 18 clinics were set up by the Ministry of Health of Iraq and 12 by other governmental organizations and NGOs. The clinics were staffed by a total of 44 health care workers. The health workers served 16,205 persons per day, an average of 540 persons per clinic, and 368 persons per health care worker per day. The majority of clinics (63% [19/30]-100% [30/30]) had basic medical diagnostic equipment. Almost all clinics had symptom relief medications (87% [26/30]-100% [30/30]). Drugs for diabetes and hypertension were available in almost half of the clinics. The majority of clinics had personal hygiene supplies and environmental sanitation detergents (78%-90%), and approximately half of the clinics had medical waste disposal supplies. Instruments for cleansing and dressing wounds and injuries were available in almost all clinics (97%), but only 4 clinics had surgical sterilization instruments.

Conclusions: Although temporary clinics were relatively equipped with basic medical supplies, equipment, and instruments for personal medical services, the health workforce was insufficient, given the number of individuals seeking care, and only limited public health service, personal infection control, and supplies were available at the clinics.

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KEYWORDS

medical staff; medical services; mass gathering; Iraq

Introduction

Background

The assembly of large masses of people in a small space for a short period has a potential health risk to both the event attendees and the local population. Such risks vary depending on the number of attendees, nature of the gathering, extent of the space, and other environmental factors, such as infrastructure and level of preparedness. These events, known as mass gatherings (MGs), have several definitions [1,2]. The World Health Organization (WHO) defines MGs as “events attended by a number of people sufficient to strain the planning and response resources of a community, state or nation” [3].

Masses gather for many reasons including religious activities, festivals, sporting events, political rallies, and other purposes. The most common religious MGs in the Middle East are the Hajj at Mecca in Saudi Arabia and the Arbaeenia in Karbala for the remembrance of Imam Hussain, celebrated by Shiite Muslims [4]. Both events occur annually.

Previous researchers had assessed the risks of communicable diseases that are associated with MGs and the risks for mortality and morbidity during MGs [4-6]. Moreover, they outlined approaches to risk assessment and mitigation, drew attention to some key challenges encountered by organizers and participants, identified most efficient public health interventions, and identified the need for robust research into health risks for noncommunicable diseases during MGs [4-7].

Infectious disease outbreaks and mass casualties have been reported during the Hajj and other MGs [8,9]. The risk of spreading infectious diseases to host countries and to other parts of the world has tremendous global health security implications and is of particular concern during MGs. In MGs, the risk of infectious diseases increases because the participants might be the source of infection or they are susceptible to infectious agents, which are circulating at the gathering location, and because of the strain on the health care system of the host countries and communities. Infectious diseases outbreaks such as foodborne diseases as a result of suboptimum food and water hygiene, respiratory infectious diseases, and other infectious diseases associated with environmental conditions have been reported during MGs [3-5,8,9].

Government health care development plan of Iraq focuses on rebuilding the health infrastructure and developing its health care workforce, which has been damaged by instability in the country [10]. Thus, services for the Arbaeenia MG, including health care services, are not well developed, hampering the ability to abate the spread of pathogens and detect and respond to outbreaks in a timely manner. Routine health care services for the Iraqi population are inadequate because of ongoing conflicts within the country [11]. The annual Arbaeenia MG further burdens the national health system, during which attendees and local communities lack adequate access to health services.

In 2014, more than 19 million people from 40 countries of the world participated in this occasion, making it the second largest gathering in the world [12]. Although this MG has complex challenges and is associated with high burden of diseases, there have been few studies on the burden of religious MGs on local health resources of Iraq. The growing number of individuals who attend the event annually, the changing dates of the anniversary, and the short duration of the event highlight the importance of preparedness plans and resources to effectively manage the gathering by national and local authorities.

Objectives

Some rudimentary health care services, such as temporary clinics and services supported by faith-based groups, are offered to the MG attendees during the journey toward Karbala. This study aimed to assess the availability of medical supplies, equipment, medical instruments, and supplies for infection control at the temporary clinics in Al-Karkh, Baghdad, Iraq. The findings of this study are expected to reflect the level of preparedness for such MGs in term of resources availability. This would assist the Ministry of Health (MOH) in Iraq to be better prepared for the next event.

Methods

Design

A cross-sectional study was conducted on temporary clinics that serve the masses walking from Baghdad to Karbala through Al-Karkh and the surrounding areas. The temporary clinics were set up by the MOH; Ministry of Interior (MOI); Ministry of Defense (MOD); nongovernmental organizations (NGOs), such as the International Red Crescent Society; and faith-based civil society organizations, locally known as *mawakib*.

The temporary clinics were set up along the road that goes through Al-Karkh, Baghdad, toward Karbala city, a distance approximately 100 km long. The masses making the trip to the Arbaeenia MG in Karbala from Baghdad and nearby provinces use this road.

Data Collection

We developed a checklist to collect the following information: clinic name, location, and affiliation (governmental or nongovernmental); availability of safe drinking water source, regular electricity, and air-conditioning system; type of building and number and category of health care workers in the clinic; and availability of basic medical equipment and instruments, drugs, and other medical supplies (developed based on the essential list of supplies determined by MOH for basic health units). The original list was acquired through personal communication with Baghdad Al-Karkh Directorate. Information on the average daily number of patients seen by the clinic was also collected.

The data were collected from December 6, 2014 (6 days before the Arbaeenia commences), and completed on December 13,

2014. The data collectors interviewed the clinic managers to complete the checklist.

Data Analysis

Statistical Package for Social Sciences version 18 (Chicago: SPSS Inc) was used for data entry and analysis. We categorized the clinics into MOH and non-MOH clinics and generated the percent distribution of clinic attributes, category of health workers, availability of basic medical equipment and drug supplies, average number of patients served per day, and availability of supplies for infection control by clinic affiliation. Data were described using percentages and means.

Results

Clinics' Characteristics

A total of 30 temporary clinics were set up along the road in Al-Karkh, Baghdad. Of these clinics, 60% (18/30) were set up

by the MOH, 12% (5/30) by the MOI/MOD, and 23% (7/30) by NGOs. Almost two-thirds of visitors who attended these clinics were from Iraq; 15% from Iran; and small percentages from Bahrain, Lebanon, Saudi Arabia, Kuwait, Pakistan, India, Oman, Afghanistan, and other countries. More than three-fourths of the patients were aged between 20 and 59 years.

Of the temporary clinics, 15 were caravans, 11 were tents, and 3 were ambulances (Table 1). The MOH clinics were predominantly caravans, whereas the non-MOH clinics were predominantly tents. Of the 30 clinics, 25 had regular electricity and 16 had clean drinking water supply. Moreover, 12 clinics had air-conditioning, of which all were MOH clinics.

Table 1. Distribution of temporary clinics by the type of construction and availability of basic requirements.

Variable	MOH ^a clinics (n=18), n (%)	Non-MOH clinics (n=12), n (%)	Total (N=30), n (%)
Type of building			
Caravan	14 (77)	1 (8)	15 (50)
Tent	2 (11)	9 (75)	11 (36)
Concrete building	1 (5)	0 (0)	1 (3)
Ambulance auto	1 (5)	2 (16)	3 (10)
Available services			
Clean drinking water supply	10 (55)	6 (50)	16 (53)
Air-conditioning	12 (66)	0 (0)	12 (40)
Regular electricity	17 (94)	8 (66)	25 (83)

^aMOH: Ministry of Health.

There were 61 workers including 26 paramedics, 18 physicians, and 17 security guards. The workers were predominantly males (67%). On average, a total of 6720 and 9485 patients had attended the MOH and non-MOH clinics, respectively. The average daily attendance per clinic was 540, and the average daily patients seen per health worker was 368.

Basic Medical Equipment/Supplies

Both MOH-affiliated and non-MOH-affiliated clinics had a sphygmomanometer and a stethoscope, and 87% (26/30) of the clinics had a glucometer. All other medical equipments were available in 30% to 73% of the clinics (Table 2).

Table 2. Distribution of Ministry of Health and non–Ministry of Health temporary clinics by availability of basic medical equipment/supplies.

Variable	MOH ^a clinics (n=18), n (%)	Non-MOH clinics (n=12), n (%)	Total (N=30), n (%)
Diagnostic equipment/supplies			
Sphygmomanometer	18 (100)	12 (100)	30 (100)
Stethoscope	18 (100)	12 (100)	30 (100)
Glucometer	16 (88)	10 (83)	26 (86)
Torch for mouth examination	9 (50)	0 (0)	9 (30)
Tongue depressor	16 (88)	0 (0)	16 (53)
Thermometer	17 (94)	2 (16)	19 (63)
Examination bed (couch)	17 (94)	5 (41)	22 (73)
Oxygen supply			
Nebulizer	15 (83)	2 (16)	17 (56)
Oxygen cylinder	13 (72)	5 (41)	18 (60)
Oxygen giving set	13 (72)	4 (33)	17 (56)

^aMOH: Ministry of Health.

Essential Medicines

All clinics had almost all the essential medicines, which included painkillers, antibiotics, antipyretics, antihistamines, ointments, hydrocortisone, and antidiarrheal drugs, with a range of 87% to 100% (Table 3). Drugs for diabetes mellitus and hypertension,

ophthalmic ointments and drops, and fluids were the least available in the clinics (<54%). Only 17% (5/30) of the clinics had all basic drugs. The MOH-affiliated clinics had higher or similar availability of all drugs compared with the non-MOH clinics.

Table 3. Distribution of Ministry of Health and non–Ministry of Health temporary clinics by availability of basic drugs.

Drugs	MOH ^a clinics (n=18), n (%)	Non-MOH clinics (n=12), n (%)	Total (N=30), n (%)
Painkiller	18 (100)	12 (100)	30 (100)
Antibiotics	18 (100)	8 (66)	26 (86)
Antipyretics	18 (100)	11 (91)	29 (96)
Antihistamine	18 (100)	11 (91)	29 (96)
Antihypertensive	15 (83)	2 (16)	17 (56)
Diabetes mellitus drugs	12 (66)	1 (8)	13 (43)
Ointments	16 (88)	19 (83)	26 (86)
Antidiarrheal	16 (88)	12 (100)	28 (93)
Ophthalmic drops and ointments	11 (61)	4 (33)	15 (50)
Distilled water for injection	17 (94)	7 (58)	24 (80)
Hydrocortisone injection	18 (100)	8 (66)	26 (86)
Fluids	13 (72)	3 (25)	16 (53)

^aMOH: Ministry of Health.

Basic Supplies for Infection Control

Almost all clinics had personal hygiene supplies, except alcohol-based handrub, which was available in approximately 60% of the clinics (Table 4). The medical waste disposal

supplies were lacking in most clinics, and less than 50% of the clinics had medical waste supplies. Environmental sanitation supplies were available in 77% of the clinics; however, only 22% of all clinics had all infection control supplies.

Table 4. Distribution of temporary clinics by basic supplies for infection control.

Supplies for infection control	MOH ^a clinics (n=18), n (%)	Non-MOH clinics (n=12), n (%)	Total (N=30), n (%)
Hand washing soap/liquid soap	16 (88)	11 (91)	27 (90)
Alcohol-based handrub	12 (66)	5 (41)	17 (56)
Disposable latex gloves	17 (94)	9 (75)	26 (86)
Disposable syringes	17 (94)	10 (83)	27 (90)
Receptacle (pedal pin) with lid and plastic bin liner	7 (38)	0 (0)	7 (23)
Sharp container safety box	14 (77)	0 (0)	14 (46)
Environmental disinfectant (chlorine or alcohol)	16 (88)	7 (58)	23 (76)

^aMOH: Ministry of Health.

Medical Supplies and Instruments

Equipment and supplies for cleaning and dressing wounds and injuries were available in almost all clinics, both MOH and

non-MOH clinics. Of the 30 clinics assessed, only 4 clinics had equipment for instrument sterilization (Table 5).

Table 5. Distribution of Ministry of Health and non-Ministry of Health temporary clinics by availability of essential medical supplies and instruments.

Essential medical supplies and instruments	MOH ^a clinics (n=18), n (%)	Non-MOH clinics (n=12), n (%)	Total (N=30), n (%)
Cotton and wraps	17 (94)	12 (100)	29 (97)
Bandages	17 (94)	12 (100)	29 (97)
Disinfectant and detergent	17 (94)	12 (100)	29 (97)
Autoclave	4 (22)	0 (0)	4 (13)
Surgical instrument for wound suturing	13 (72)	4 (33)	17 (57)

^aMOH: Ministry of Health.

Discussion

This assessment focused solely on the availability of medical supplies, medical equipment, and instruments for personal medical services, emergencies, nonemergency health problems, and infection control at the clinic level. The assessment of temporary clinics serving the masses walking toward Karbala from Al-Karkh, Baghdad, and surrounding areas showed that the supplies and manpower in the clinics demonstrated some capacity to handle minor common ailments encountered during the Arbaenia MG. MOH clinics were more equipped with diagnostic equipment/supplies than non-MOH clinics. This reflects poor planning and coordination of services and highlights the need for coordination between MOH and other ministries and NGOs to ensure the availability of supplies and equipment in all clinics. The public health sector's preparedness for MGs requires a huge investment of time, organization and intersectoral collaboration, planning epidemiological surveillance, organization of control and prevention measures, organization of health care services, and management of cases and casualties.

The drug supplies found in the clinics were useful for several ailments: (1) nonspecific symptom relief such as pain, fever, diarrhea, eye problems, and allergies; (2) antibiotic-treatable infections; (3) dehydration; and (4) chronic diseases (eg, diabetes mellitus and hypertension). Medical instruments needed to clean and dress wounds and injuries were available in the majority of clinics. Such instruments are much needed during such MGs

because injuries are common during the MG [13]. Autoclaves for sterilizing surgical instruments were rare. Poor availability of sterilizing equipment might increase the hazards of infections. The MOH of Iraq should ensure the availability of such equipment in all clinics providing health services.

The health professionals in the clinics were physicians and paramedics. The ratio of paramedics to the physicians in the clinics assessed was 1.4:1, which is close to the ratio in Iraq (1.8:1) [14]. One-tenth of temporary clinics were ambulances. The capacity of the clinics and the number of health professionals were not adequate to serve the participants of the MG, as indicated by the average number of persons per clinic and per staff. The portion of the participants traveling from Al-Karkh, Baghdad, to Karbala in of need ambulance services was not known, and thus, the adequacy of ambulance service and its distribution along the road was not studied and could not be determined in this assessment.

The infection control materials for personal hygiene and control of infection and environmental sanitation were mostly available at the clinics. Medical waste disposal materials were rarely available at the clinics, which could pose a risk of infection to the patients at the majority of temporary clinics. The WHO Epidemic and Pandemic Alert and Response document [15] can be used by the MOH of Iraq to guide those responsible for the health needs of individuals attending an MG and to help them plan their actions.

The environmental conditions, such as safe drinking water supply, air-conditioning, and electricity, were mostly adequate, particularly for the MOH clinics. The non-MOH clinics were not equipped with air conditioners, which are important for the health and safety of patients, given the desert environment. Water and food safety and compliance with health conditions should be ensured before and during the event. Food handlers should be trained and provided with working guidelines for safe food handling, and their practices should be inspected and monitored during the event.

The priority during MGs is often to manage emergency and nonemergency personal medical problems and injuries of the attendees. The importance of safeguarding the larger global population from outbreaks of infectious diseases becomes a secondary priority during the MG. The Arbaeenia MG is becoming increasingly populous, and the government is not well prepared for managing imminent health emergencies and mass casualties. This assessment shows that various government ministries were involved in providing services to the masses walking to Karbala for the religious event, demonstrating a commitment from the Government of Iraq to address the needs of MG participants. Although the services were mainly medical services, some form of public health services accompanied the medical services, including personal hygiene and infection control supplies and medical waste disposal supplies. The public health impact of such services needs to be assessed in the future.

During MG, the health planners should consider the provision of care that is consistent with local standards of care for

participants; meanwhile, they have to ensure the availability of continuing medical service to the populations surrounding the event venue and be vigilant and well prepared to respond to unusual events.

The MG in Karbala requires prior national planning, which the government understands, as demonstrated by its level of involvement. However, Iraq is undergoing continuous violence and war and is therefore limited in its capacity to plan for and provide adequate services to MG participants to protect the local and global populations from the spread of infectious diseases.

In conclusion, although temporary clinics were relatively equipped with basic medical supplies, equipment, and instruments for personal medical services, the health workforce was insufficient, given the number of individuals seeking care, and only limited public health service, personal infection control, and supplies were available at the clinics. This assessment should assist the Government of Iraq to develop an adequate plan for services at the annual Arbaeenia MG to develop rigorous national standards for provision of medical care during MGs. WHO's global health initiatives and key considerations [3] should be considered in the process of setting up and implementing public health alert, response, and operational plans for MGs. These initiatives provide advice about prevention, detection, and management of public health incidents as well as the integration of the full range of public health activities into the MG planning process.

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Conflicts of Interest

None declared.

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Abbreviations

MG: mass gathering

MOD: Ministry of Defense

MOH: Ministry of Health

MOI: Ministry of Interior

WHO: World Health Organization

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Viewpoint

The Eastern Mediterranean Public Health Network: A Resource for Improving Public Health in the Eastern Mediterranean Region

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Abstract

Countries in the Eastern Mediterranean Region (EMR) face many challenges in terms of improving population health and progressing toward sustainable development goals (SDGs). This paper aims to describe the approach taken by the Eastern Mediterranean Public Health Network (EMPHNET) to help strengthen health systems in the EMR and enable progress toward sustainable development targets, the tools it used, and its achievements. The EMPHNET is a nonprofit organization that has worked to support EMR countries in strengthening their public health systems since its establishment in 2009. The EMPHNET invests in building workforce capacity in applied epidemiology by supporting field epidemiology training programs in more than 10 countries in the EMR, while ensuring country ownership of these programs. The EMPHNET established the Global Health Development (GHD) to maximize support for positive change and SDG progress. As an implementing arm to the EMPHNET, GHD aligns its strategies with national policies and directions. The GHD/EMPHNET works at the regional, national, and subnational levels and tailors solutions for the local context. Over the past years, the EMPHNET succeeded in partnering with over 13 countries and provided technical assistance to leverage country efforts and maximize resource use. The EMPHNET's Center of Excellence for Applied Epidemiology focuses on building capacity in population health and applied epidemiology. The EMPHNET supports countries in delivering effective public health programs by building capacity and conducting research to prevent and control emerging and reemerging diseases, vaccine-preventable diseases, and noncommunicable diseases. The commitment to the region, together with the increased trust and assertion from the countries, helped GHD/EMPHNET build a strong portfolio, which was made possible by the interconnected effort that continues to nurture and foster better health among people living in the EMR.

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KEYWORDS

field epidemiology; public health; training; research

Introduction

The Eastern Mediterranean Region (EMR) embraces countries that vary in economic growth and development level, which significantly affects the health status of the populations in these countries. Regardless of the economic and development level, all EMR countries are facing an increase in the prevalence of noncommunicable diseases [1], with many countries still suffering from the double burden of disease where communicable diseases remain common. Further, EMR countries face many challenges in improving population health and progressing toward sustainable development goals (SDGs)

[2]. Progress toward achieving SDGs in several EMR countries is constrained by many shortcomings that hinder improvement in health outcomes such as limited resources, conflict, and political instability [3]. In most countries of the region, programs that address the key health challenges [4] are limited because of limited capacity in public health. In some countries, public health improvement was challenged by emergencies, crises, refugees, and displacement [5].

This paper aims to describe the approach, tools, and achievements of the Eastern Mediterranean Public Health Network (EMPHNET) toward strengthening health systems in

the EMR and progressing toward the sustainable development targets.

The Eastern Mediterranean Public Health Network

The Eastern Mediterranean Public Health Network (EMPHNET) is a nonprofit organization that has worked to support EMR countries in strengthening their public health systems since its establishment in 2009. The EMPHNET invests in building workforce capacity in applied epidemiology by supporting field epidemiology training programs (FETPs) in more than 10 countries in the EMR, while ensuring country ownership of these programs. Increasing demand from several EMR countries to develop their capacities in various areas of public health urged the EMPHNET to expand its efforts in capacity building to address key health priorities and gaps that cover essential public health areas, such as outreach and emergency, bio-risk management, communicable diseases, and health protection and promotion. Its vision is to see people in the EMR lead healthy lives and better welfare. Its mission is to prevent and control diseases, conduct and support operational research for priority public health domains, and strengthen public health programs while working jointly with similar institutions associations, networks, and organizations. EMPHNET's website [6] displays a lot of information on various tools and approaches, activities, success stories, and achievements of the EMPHNET in the EMR.

The Eastern Mediterranean Public Health Network's Efforts Toward Sustainable Development Goals

The EMPHNET believes that change and transformation are key elements for progressing toward the SDGs and that health is a basic right for all human beings wherever they live. EMPHNET's work is driven by a deep interest and belief in the importance of achieving universal health coverage, which influence its initiatives and strategies. Therefore, consistent with the SDG's motto, "Ensure healthy lives and promote well-being for all at all ages" [7], the EMPHNET adopted a transformational vision that guides its role and efforts toward assisting EMR countries strengthen their health systems. Such efforts contributed to meeting key health priorities and gaps that cover essential public health areas, such as health security, emergency preparedness and response, noncommunicable diseases, and communicable diseases. In maximizing its contribution to the SDGs, the EMPHNET acknowledged the role of different factors in influencing health and viewed many of the SDG challenges (such as those related to poverty, hunger, education, inequality, and climate change) as detrimental to achieving a healthy well-being. The EMPHNET also acknowledged the essential role of public health institutions across the globe to achieve the SDG targets. Therefore, the EMPHNET works on building national, regional, and global partnerships under SDG17 [4] as well as secure global health opportunities as an innovative strategy to support EMR countries build robust health systems to meet the SDG challenges.

With this context, the EMPHNET established the Global Health Development (GHD) as an asset to maximize support toward positive change by seizing opportunities for backing up countries in influencing SDG progress. GHD was initiated to advance the work of the EMPHNET by building coordinating mechanisms with Ministries of Health, International Organizations, and other institutions to improve population health outcomes. As an implementing arm to the EMPHNET, GHD aligns its strategies with national policies and directions. Serving as a collaborative platform, the GHD/EMPHNET is dedicated to serve the region by supporting national efforts to promote public health policies, strategic planning, sustainable financing, resource mobilization, public health programs, and other related services.

The Eastern Mediterranean Public Health Network's Approach to Strengthening Health Systems

The GHD/EMPHNET adopts a comprehensive approach process to health system strengthening, where it works at different levels to identify and respond to health challenges. The GHD/EMPHNET works at the regional, national, and subnational levels and tailors solutions to the local context. Its approach triggers change by reinforcing knowledge through regional, national, and subnational activities and using a proactive learning approach to bring about effective problem solving and ownership of outcomes. The GHD/EMPHNET's commitment to support countries bring about change at the frontline level is supported by a bottom-up approach to health system strengthening, where action planning and program management are transformed at the peripheral level, thus producing national-level change.

In supporting countries to address health priorities, the GHD/EMPHNET puts emphasis on engaging and involving stakeholders, which is viewed as an effective strategy for identifying potential opportunities and maximizing the use of resources for rolling out broader actions to improve health outcomes. The GHD/EMPHNET implements operational research to generate information that can link policy to practice and engage in implementation research that contributes to countries' efforts to reach SDG targets through knowledge synthesis. This approach helps generate evidence from the region to share with the global health sector.

Global Health Development/Eastern Mediterranean Public Health Network's Working Areas

Over the past years, the EMPHNET succeeded in partnering with over 13 countries and has worked in close collaboration with a wide range of institutions, partners, and implementers; with different health providers and practitioners; and has provided technical assistance to leverage country efforts and maximize resource use. The deeply rooted collaboration with countries allowed the GHD/EMPHNET to drive and direct opportunities to correspond to priority needs of the countries. Further, the strategy helped expand efforts and tailor new

working areas that target essential public health functions in addition to focusing on applied epidemiology, which was the initial onset area of concern.

Workforce Development

Investing in health workforce development is a key factor in strengthening health systems and supporting progress toward reaching SDG targets. Building a stronger public health workforce improves health system performance by contributing to more effective service delivery. EMPHNET's Center of Excellence for Applied Epidemiology focuses on building capacity in population health and applied epidemiology. The EMPHNET is committed to support field epidemiology training programs (FETPs) in EMR countries, as these programs are crucial for assuring core epidemiologic competencies. These programs aim at applying scientific methods in the field, such as using epidemiologic methods to investigate health problems or outbreaks or analyzing data gathered through surveillance or other methods to generate evidence for decision makers. Core competencies gained by FETP training add value to meeting the international health regulations by building surveillance capacity and improving efficiency in monitoring disease incidence, prevalence, determinants, coverage, program evaluation, and expenditure data. In addition, FETP training plays a crucial role in strengthening the response to unexpected health problems or events, thus containing and preventing their spread. Integrating applied epidemiology concepts in strengthening a range of services is crucial because skilled field epidemiologists are the core of a robust public health system.

Public Health Programs

Preventing and controlling communicable and noncommunicable diseases is essential for assuring healthy living and well-being. The EMPHNET supports countries in delivering effective public health programs by building capacity and conducting research to prevent and control emerging and reemerging diseases, vaccine preventable diseases, and noncommunicable diseases. Focus areas under this domain include disease control, outreach and emergency, polio and immunization, health protection and promotion, environmental health, and disease of special concern. Since all health-related SDG targets cover health concerns that countries need to address by developing health programs and related interventions, the GHD/EMPHNET supports EMR countries in developing and strengthening public health programs and in supporting countries translate global initiatives, strategies, and action plans.

Research and Policy

Monitoring progress and performance is important for assuring progress toward SDG targets. The GHD/EMPHNET supports countries in building robust and reliable information to support translating information into policies. The GHD/EMPHNET works with a range of institutions and builds research experience for field epidemiologists, public health practitioners, and young researchers while highlighting data collection challenges and providing appropriate digital solutions. The GHD/EMPHNET collaborates with academic and nonacademic institutions and

similar organizations to generate evidence that can guide policies by focusing on aspects such as operational research, assessments and surveys, secondary data analysis and information generation, public health program monitoring, and evaluation studies.

Communication and Networking

Effective communication and broad networking are important for assessing gaps and planning and delivering different health programs. The GHD/EMPHNET created a network of public health professionals and experts in the EMR to support program development and service delivery. It also invested in communication and used it to advance information sharing, as it is a key element for assuring robust data systems that countries need to secure to monitor their progress toward SDG targets. EMPHNET's networking efforts allowed to integrate capacities when assisting countries to explore solutions for meeting the challenges. The GHD/EMPHNET remains committed to network regionally and globally with Ministries of Health, regional, and international organizations as well as private sector and academic institutions to attract opportunities and partnerships that support investment in programs that support implementation of the SDGs.

The Eastern Mediterranean Public Health Network's Networking and Knowledge Exchange Platforms

Internship

The GHD/EMPHNET provides an opportunity for students and fresh graduates to work in and learn from working in a rapidly expanding, multifield public health organization. The internship program allows candidates to work in GHD/EMPHNET's different work settings, while supporting their own initiatives or projects. The GHD/EMPHNET provide interns with an opportunity to apply professional public health competencies and skills, thus preparing them to work with confidence in real public health settings. Interns at the EMPHNET are mentored by skilled and experienced supervisors who supervise their internship and help them link theory to practice. The GHD/EMPHNET matches the career interest and preference of interns with work situations that allow them to maximize the use of the knowledge they gained during school education. GHD/EMPHNET's internship program is in high demand, with candidates seeking experience in different areas including infectious diseases, applied epidemiology, health promotion, media, and communication.

Field Epidemiology Exchange Program

Considering the diversity of public health emergencies, outbreak investigations, and challenges in the EMR, it is of great importance that FETP residents or students studying public health at a university are exposed to a broad range of field experiences. As a leading regional public health network, the GHD/EMPHNET strives to provide an exchange platform to promote applied epidemiology experience sharing between countries, as the levels of health care and system development differ among EMR countries. This exchange program seeks to

expand the network of public health experts and field epidemiologists in the region by promoting a diverse field experience. By establishing the FEEP, the GHD/EMPHNET provides the FETP residents and university students an opportunity to join FETP programs in EMR countries for a specific period of time for the purpose of gaining new experiences. Such a program was established in response to a request by FETPs and public health academic institutions in the EMR based on a need to foster public health competencies. In addition to the exchange and network expansion benefits, the FEEP aims to strengthen regional public health emergency response as well as promote coordination between ministries of health in the region. The program will result in an increased number of epidemiologists trained in surveillance and field investigations, who are capable of defining health measures to control disease outbreaks in the region.

Conferences

The EMPHNET works to link, support, and strengthen public health programs in EMR countries and beyond. The EMPHNET's biannual regional conference is an opportunity for public health professionals and field epidemiologists working in the EMR to exchange experience and be exposed to new ideas and skills. The conference presents a platform to "showcase" achievements in research, outbreak investigations, assessments, and evaluation. In addition to public health networking, the conference provides the region with a special opportunity for demonstrating progress and innovation in applied epidemiology across countries. To date, the EMPHNET has conducted six regional conferences, where over 1000 scientific research works were presented. The number of submissions and accepted abstracts to the EMPHNET conferences escalated over the years, making such conferences recognizable with a competitive pursue.

EpiShares

The GHD/EMPHNET developed and launched a networking platform (EpiShares) designed to join public health professionals and experts in a space where they can express thoughts, address concerns, and discuss issues relevant to public health issues. As a unique public health community of practice, EpiShares enables public health professionals and experts to come together to reflect and explore solutions necessary for managing public health challenges and doubtful situations in various settings. Through EpiShares, the GHD/EMPHNET taps into advances in technology to offer an ideal environment that would grant members a chance to ponder into a common space where they can examine interests of other colleagues, identify colleagues with mutual interests, and seek the advice or opinion of experts. The GHD is enabling members of EpiShares to share articles, opportunities, tools, training resources, and other essential

elements needed to enhance their performance and expand their scope and perspectives. EpiShares will be the space that will embrace its members' credentials and grow into a powerful public health sphere whereby experts can be accessed and contacted for building initiatives, programs, or schemes.

The Eastern Mediterranean Public Health Network's Public Health Forum

Acting as a forum for public health professionals in EMR since 2009, the EMPHNET officially established a Public Health Forum (PHF) in 2018 to serve as a platform that brings together public health professionals to discuss and get involved in issues that affect public health practice. Modelled to support improvements to public health, the EMPHNET-PHF is involved in networking between different health sectors to improve public health and contributing to debates and discussions that can shape or influence public health policy. The EMPHNET-PHF brings different stakeholders and professionals together while working actively to promote dialogue that influences policy making. This forum works by holding regular meetings to discuss concerns and issues that challenge public health.

Challenges

One of the main challenges facing the EMPHNET is the that many of its activities are carried out in countries that are politically unstable or in crisis. These conditions might limit the movement of staff to attend the EMPHNET workshops and events. However, there are several enabling factors that allow the EMPHNET to affect change and contribute to better performing health systems in EMR countries. These factors stem from internal and external strengths and contextual factors that help maximize the effect and impact of opportunities sought to address challenge and from collaboration with governments and employment of a network of experts and professionals to conduct research and produce training material, toolkits, and guidelines.

Conclusions

Since its establishment in 2009, the EMPHNET implemented activities to support strengthening of public health systems in EMR countries. Through collaborative efforts with partners and cooperation with ministries of health, the GHD/EMPHNET managed to reach a status that is recognized in the global arena. The commitment to the region together with the increased trust and assertion from the countries helped the GHD/EMPHNET build a strong portfolio made possible with interconnected effort that continues to nurture and foster merit for better health among people living in the EMR.

Conflicts of Interest

None declared.

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Abbreviations

EMPHNET: Eastern Mediterranean Public Health Network
EMR: Eastern Mediterranean Region
FETP: field epidemiology training programs
GHD: Global Health Development
PHF: Public Health Forum
SDG: sustainable development goal

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Original Paper

Outbreak Investigation of a Multipathogen Foodborne Disease in a Training Institute in Rabat, Morocco: Case-Control Study

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Abstract

Background: On June 18, 2017, the public health service was alerted about 43 students in the training institute in Rabat who were admitted to the emergency room for acute gastroenteritis following the uptake of a meal a day before.

Objective: This study aimed to investigate the foodborne disease outbreak by confirming the outbreak, identifying the source of contamination, and recommending control measures.

Methods: We conducted a case-control study. Cases and controls were selected in a ratio of 1:1. We defined a case as any member of the training institute who attended the Ramadan buffet in the institute's restaurant and who had presented, in the weekend of June 16 to 20, 2017, symptoms of diarrhea or vomiting with at least one of the following signs: abdominal pain, fever, headache, nausea, and dizziness. A control was defined as anyone who attended the Ramadan buffet in the institute's restaurant but had not presented any symptoms from June 16 to 20, 2017. We conducted a bivariate and multivariable analysis. Stools of ill students were collected, and a food specimen was collected for bacterial testing.

Results: A total of 50 cases and 50 controls were selected. Among the cases, males were predominant (43/50, 86%); the median age was 21 years. A total of 47 cases sought medical care. There were no hospitalizations and no deaths. The episode was short with an estimated average incubation period of 9 hours. The epidemic curve oriented toward a common source of contamination. Among food items, briwates were strongly associated with the illness with an odd ratio of 14.23 (95% CI 5.04-40.04; $P < .001$). Laboratory testing of briwates showed presence of *Escherichia coli* O157 and *Staphylococcus aureus*.

Conclusions: This foodborne disease outbreak was likely caused by briwates that was contaminated with *S aureus* and *E coli*. We recommended strengthening hygiene measures. Food handling techniques should be taught as part of continuous professional development for food handlers.

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KEYWORDS

disease outbreaks; foodborne diseases; Staphylococcus; Escherichia coli

Introduction

Acute collective food poisoning or foodborne disease outbreak (FBDO) occurs when 2 or more people develop a similar illness after ingesting the same contaminated food or drink [1]. Illness and death from diseases caused by contaminated food are a constant threat to public health and a significant impediment to socioeconomic development worldwide. It remains a major public health challenge regardless of being underreported [2].

The causes of foodborne illness include viruses, bacteria, parasites, toxins, and metals. The symptoms of foodborne illness range from mild gastroenteritis to life-threatening neurologic, hepatic, and renal syndromes. The main microorganisms responsible for the FBDO are *Salmonella*, *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus*, and *Campylobacter* [2,3]. According to the World Health Organization's estimates in 2010, there would be 600 million cases of foodborne illness per year with more than 400,000 deaths [4]. Data released by the Centers for Disease Control and Prevention's (CDC) Foodborne Diseases Active Surveillance Network (FoodNet) for 2016 demonstrated that the United States continues to make little progress in driving down the rates of infection by bacteria commonly transmitted through food [5]. In addition, in 2016, the CDC estimated the number of foodborne illness at 48 million cases annually with 128,000 hospitalizations and 3000 deaths [5,6].

In Morocco, an average of 100 FBDO episodes are reported annually, corresponding to 1500 cases notified by all provinces and regions of the kingdom. However, the laboratory confirmation rate remains very low, not exceeding the 10% threshold. In fact, according to the Department of Epidemiology and Disease Control (DEDC), during the period 2007 to 2017, 13,778 cases of FBDO were identified, of which 57.1% of the households were declared in a family environment, and 42.9% of these outbreaks were reported in communities [7].

Surveillance of foodborne illness is complicated by several factors including underreporting. Although a foodborne illness can be severe or even fatal, milder cases are often not detected through routine surveillance [8,9]. Many pathogens transmitted through food are also spread through water or from person to person, thus obscuring the role of foodborne transmission. Finally, some proportion of foodborne illness is caused by pathogens or agents that have not yet been identified and thus cannot be diagnosed. The importance of this final factor cannot be overstated. Many of the pathogens of greatest concern today (eg, *Campylobacter jejuni*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, and others such as *Cyclospora cayetanensis* and Norovirus) were not recognized as causes of foodborne illness just decades ago [10]. Any episode of FBDO should be considered as an emergency and should be investigated immediately. The purpose of the investigation of FBDO was to avoid any extension and to prevent recurrences contributing to food security [6,10].

On Sunday, June 18, 2017, at 5 am, 30 students at the training institute in Rabat, who a day before had attended the Ramadan buffet in the canteen, exhibited the following gastrointestinal

symptoms: diarrhea, nausea, vomiting, abdominal cramps, fever, and dizziness. Given the high number of affected cases and the coincidence of this crisis with the period of school end-of-year, this situation triggered a state of health emergency. At 9 am, 43 students among the 392 registered in this institute were admitted to the emergency room of the University Hospital in Rabat with symptoms of gastroenteritis. The director of the hospital quickly reported those cases to the regional health director of Rabat-Salé-Kenitra who alerted the Provincial Epidemiology Unit.

Owing to the large number of cases identified, similarities, commonality and location, the symptoms, and the occurrence context, an FBDO was suspected and an outbreak investigation team from the Field Epidemiology Training Program (FETP) and DEDC was immediately requested to initiate the outbreak investigation.

The investigation aimed to confirm the FBDO and to identify the source(s) of contamination and the causal agent to implement control measures and prevent further cases. A case control study was performed to identify specific risk factors associated with the occurrence of the foodborne illness outbreak in that institution.

Methods

Epidemiological Investigation

The outbreak investigation team, including 2 FETP fellows, visited the training institute in Rabat to collect all data related to the FBDO. The list of foods items in the menu of the last 3 days were recorded from the subcontracting company along with the list of persons admitted to the hospital. A structured questionnaire was developed to collect information about the food consumption and sociodemographic and clinical data of patients. An Excel sheet was used to develop the epidemic curve. All the necessary authorizations were obtained from the DEDC director and the regional health director of Rabat-Salé-Kenitra.

Laboratory Investigation

Following notification of the outbreak, stool samples were collected for bacteriological analysis from 2 students admitted at the emergency department of the hospital. Meanwhile, bacteriological sampling was recommended for all restaurant staff to identify the presence of possible healthy carriers, especially for *Staphylococcus*. Food sampling was performed on the leftovers obtained from the institute's restaurant. Food samples were sent to the National Reference Laboratory of the National Hygiene Institute and tested for *Salmonella*, *Shigella*, pathogenic *E coli*, *Campylobacter*, *Bacillus cereus*, *Clostridium*, *Yersinia enterocolitica*, and *S aureus* and its toxin. A bacteriological analysis was done for the following items: chicken briwates, pastries, turkey steak, minced meat, madeleine, harcha, meloui, orange juice, and yogurt.

Environmental Investigation

According to the general principles of food hygiene [11], an environmental assessment was undertaken by a multidisciplinary team, and the caterer's premises were inspected to identify the conditions that may have contributed to the occurrence of the

outbreak. The following critical points were inspected: the kitchen, the storage area, the sanitary rooms, the hot chain, the cold chain, and the catering area.

Analytical Phase—Case-Control Study

We conducted a case-control study. Cases and controls were selected in a ratio of 1:1. We defined a case as any member of the training institute who attended the Ramadan buffet in the institute's restaurant and who had presented, in the weekend of June 16 to 20, 2017, symptoms of diarrhea or vomiting with at least one of the following signs: abdominal pain, fever, headache, nausea, and dizziness. A control was defined as anyone who attended the Ramadan buffet in the institute's restaurant but had not presented any symptoms from June 16 to 20, 2017.

Data Analysis

A descriptive analysis was conducted on the basis of person, time, and place. Results have been presented using means or medians for quantitative variables and percentages for qualitative variables. An epidemic curve has been drawn with daily time steps and a 2-hour time interval. We also analyzed the distribution of onset of symptoms and demographic characteristics. A univariate analysis was performed to compare characteristics and exposure of cases and controls using the chi-square or Fisher Exact tests for categorical variables and *t* test or Wilcoxon test for continuous variables. Odds ratio (OR) and 95% CI were calculated for each exposure variable of interest (food items) and a *P* value of <.05 was considered statistically significant. A multivariate analysis was performed by using logistic regression. Data were collected and analyzed using Epi Info7 (CDC).

Results

Epidemiological Investigation

We identified 50 patients who consumed the suspected meal in the institute's restaurant. Of those, 43 were males (86%) with a median age of 21 years (range 20-27 years) and an average of 21.86 (SD 1.4) years. The most frequent symptoms were diarrhea (50/50, 100%) and abdominal pain (49/50, 98%), followed by nausea (26/50, 52%), fever (18/50, 36%), dizziness (9/50, 18%), and vomiting (8/50, 16%). Bloody diarrhea was reported in 2 cases. A total of 43 students were transferred to the hospital, and case patients had complete resolution of symptoms with no hospital admission and no death.

The control population consisted of 31 men (62%) and 19 women (38%) with men to women sex ratio of 1.63. Among

50 controls, the median age was 22 years (range 18-47 years) and an average of 23.8 (SD 5.0) years.

[Multimedia Appendix 1](#) shows the epidemic curve. The first 2 cases presented symptoms between 10 pm and 12 pm on June 17, and the number of cases peaked early in the morning on June 18, and the last reported illness onset was in the same day. The average incubation period was estimated as 9 hours.

The only common exposures shared by all case patients were food from the institute's restaurant during a Ramadan dinner. On the basis of this information, the hypothesis was that the consumption of contaminated food from the institute's restaurant was the source of the outbreak.

Laboratory Investigation

The stool results of 2 patients were negative. *Staphylococcus aureus* and *E coli* 0157 H7 were isolated from food samples of briwates at levels exceeding the acceptable thresholds. In addition, coliform testing identified briwates contamination with coliforms. There was no result from testing among food handlers.

Environmental Investigation

The inspection of the kitchen premises by the investigation team revealed the following:

- Defects in the design and maintenance of the restaurant premises: cracks in the ground with water infiltration.
- Unsatisfactory hygiene conditions with lack of hand washing and hand drying.
- Poor condition of the cold room, with a nonfunctional temperature indicator.
- Poor state of the laundry room and utensils stored in inadequate conditions.
- Presence of vectors in the kitchen (roaches and mosquitoes).

Analytical Phase—Case-Control Study

[Table 1](#) shows the food items consumed by cases and controls, a day before the onset of illness. In the univariate analysis, the exposure that was highly associated with the diseases was eating briwates (OR 14.2, 95% CI 5.05-40.04). In the multivariate analysis, the briwates eaten at dinner a day before remained strongly associated with the illness (OR 56.71, 95% CI 12.11-265.65; [Table 2](#)). Meanwhile, eating harcha and meloui appeared as protective factors with an adjusted OR of 0.06 and 0.14, respectively. Among briwates consumers, a significant association was noted between the occurrence of illness and meloui and harcha concomitant consumption ([Table 3](#)).

Table 1. Food items associated with the illness during a foodborne outbreak in a training institute in Rabat on June 18, 2017.

Food item	Cases, n (%)	Controls, n (%)	Odds ratio (95% CI)	P value
Briwates ^a	44 (88)	17 (34)	14.2 (5.05- 40.04)	<.001
Jam	2 (4)	8 (16)	0.22 (0.04-1.08)	.09
Cheese	26 (52)	41 (82)	0.23 (0.09-0.59)	.01
Harcha ^b	9 (18)	23 (46)	0.25 (0.10-0.64)	.01
Milk	13 (26)	20 (40)	0.52 (0.22-1.23)	.13
Madelaine	12 (24)	25 (50)	0.31 (0.13-0.74)	.01
Meloui ^c	8 (16)	19 (38)	0.3 (0.11-0.77)	.01
Eggs	27 (54)	30 (60)	0.78 (0.35-1.73)	.54
Bread	4 (8)	2 (4)	2.08 (0.36-11.95)	.67
Milk products	2 (4)	8 (16)	0.22 (0.04-1.08)	.09
Seffa ^d	8 (16)	6 (12)	1.39 (0.44-4.36)	.56
Turkey steak	8 (16)	3 (6)	2.92 (0.72-11.74)	.19
Minced meat	4 (8)	11 (22)	0.30 (0.09-1.04)	.09
Pastry	13 (26)	14 (28)	0.90 (0.37-2.18)	.82

^aA traditional food prepared with chicken mixed with condiments, vermicelli, chopped onions, and eggs and manually wrapped by hand in a sheet of brick.

^bA cake prepared with semolina, butter, and milk or water.

^cA traditional pancake.

^dA sweet couscous made with vermicelli, cinnamon, and almonds.

Table 2. Adjusted odds ratios for food items associated with the illness during a foodborne outbreak in a training institute in Rabat on June 18, 2017

Food item	Adjusted odds ratio (95% CI)	P value
Briwates ^a	56.71 (12.11-265.65)	<.001
Harcha ^b	0.06 (0.01-0.27)	<.001
Meloui ^c	0.14 (0.03-0.58)	.01

^aA traditional food prepared with chicken mixed with condiments, vermicelli, chopped onions, and eggs and manually wrapped by hand in a sheet of brick.

^bA cake prepared with semolina, butter, and milk or water.

^cA traditional pancake.

Table 3. Association between the illness and consumption of meloui and harcha among the 61 consumers of briwates during a foodborne outbreak in a training institute in Rabat on June 18, 2017.

Food item	Cases (N=44), n (%)	Controls (N=17), n (%)	Odds ratio (95% CI)	P value
Harcha ^a	8 (18)	14 (82)	0.04 (0.01-0.2)	<.001
Meloui ^b	8 (18)	8 (50)	0.2 (0.06-0.7)	.01

^aA cake prepared with semolina, butter, and milk or water.

^bA traditional pancake.

Discussion

Principal Findings

A food poisoning outbreak occurred among participants at the Ramadan buffet in the canteen in a training institute in Rabat. This is consistent with the definition of a food poisoning outbreak [4,5]. Our results indicated that there was a strong

association between patients' status and eating briwates served at the Ramadan buffet on June 17. A total of 50 students had onset of food poisoning symptoms ranging from 2 hours to 17 hours after consuming a food item, consistent with the usual incubation period of foodborne illness related to *S aureus*, which is usually from 1 hour to 6 hours [12].

In our study, most case patients had minor symptoms; only 2 patients had bloody diarrhea. Symptoms had resolved within 1 hour after admission for the 43 patients who exhibited symptoms and visited the emergency department. This is in line with *Staphylococcus* food poisoning with a very rapid onset, usually within few hours after ingestion of contaminated food. In addition, only an estimated 10% of patients visited the hospital [13].

The epidemic curve suggests a significant point-source foodborne outbreak. *S aureus* and *E coli* 0157 H7 were isolated from food samples of briwates. The mixture of these microorganisms could have been responsible for this outbreak. However, the microbiological tests of collected stool samples from 2 cases were negative.

It should be noted that during the preparation of the briwates, the chicken is cut into small pieces and mixed with condiments, vermicelli, chopped onions, and eggs and then manually shaped and wrapped by hand in a sheet of brick in triangular form. It is stored at room temperature before being fried and placed in a cool place. The meals served on the menu of June 17, 2017, had been prepared the day before by several cooks at the caterer's premises. It was not possible to know whether the farce of briwates was kept at night or not before being packed in the brick sheets. It is commonly known that FBDOs in institutional settings, where food prepared several hours before it has been served, are frequent and several micro-organisms are implicated, such as *E coli*, *S aureus*, *Salmonella species*, or even *C jejuni* and viruses [14].

It is demonstrated that foods requiring several manipulations during their preparation are frequently exposed to contamination by *Staphylococcus* and *E coli*, and the food handlers are often the main source of transmission [12,14].

The literature surrounding staphylococcal food poisoning outbreak publications is rare because of it being underreported. Food poisoning is a short-term illness and usually results in full recovery; doctors do not take it very seriously, especially when the outbreak affects only a few people [8,9,15].

In Morocco, in 2016, the estimated incidence rate of foodborne disease was 4/100,000. Compared with other close areas, this rate was varying between the extremes of European values observed in Europe: 0.06/100,000 in Greece and 8.98/100,000 in Malta [7,16].

Few reports on foodborne illness outbreaks were published in Morocco. Over the last 6 years, 2 food poisoning outbreaks were reported in training institutes in almost similar circumstances. The first foodborne illness occurred in a training institute in Agadir, reported in 2011. That outbreak investigation indicated that there was an association between gastrointestinal illness and the consumption of hamburger and mayonnaise.

Confirmed isolates of *Salmonella* unspecified were detected in the food items [17]. The second occurred in 2016 in a training institute in Rabat. It was related to the consumption of hamburger and milk semolina. *Salmonella* was isolated in hamburger, and *E coli*, in milk semolina and hamburger [18]. These 2 episodes led to the observation of 59 and 64 patients, respectively [17,18].

The average number of persons per outbreak in Moroccan published reports (58 persons per outbreak) was higher than that estimated from data reported by the European Food Safety Authority in 2016 (3.6 persons per outbreak). However, our estimation is limited only to 3 published reports, including this one.

The proportion of patients admitted in emergency rooms as a consequence of a foodborne disease in our study (86%) was higher than that reported in 2011 outbreak.

Among the strengths of our investigation is the prompt notification of the outbreak to the health authorities that facilitated rapid implementation of the first response actions. In addition to that, there was a quick case follow-up and sealing of the available food samples by environmental health inspectors. An active investigation of cases was conducted, and a face-to-face interview took place by applying a standardized questionnaire. These activities limited information biases related to the self-administered questionnaire. Finally, the collaborative work of the investigation team members, including epidemiologists, laboratory technicians, and environmental health inspectors, allowed for the rapid identification of the source of contamination.

There is a need for accurate data and strong evidence on the type of vehicles, causative agent, and the diversity of the isolated strains during an FBDO investigation. This study illustrates a dual-pathogen-related outbreak, which is not unusually reported in many foodborne outbreak investigations elsewhere [19].

One of the limitation of this study is that the enterotoxin was unknown although that the microbiological testing of food samples identified *Staphylococcus aureus*.

Conclusions

In conclusion, there was evidence that the pathogens responsible for the food poisoning associated with the consumption of contaminated briwates were *S aureus* and *E coli*. The study illustrates the impact of gaps in the food handler control program, especially the lack of regard for hygiene best practices in collective catering. To reduce food contamination, continuous training on hygiene best practices, such as hand washing and use of gloves and protective clothing in kitchen areas, should be implemented. More attention should be paid by food handlers to ensure hand hygiene practices are followed to prevent a foodborne outbreak.

Acknowledgments

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Epidemic curve of a foodborne outbreak in a training institute in Rabat on June 18, 2017.

[[PNG File 10 KB - publichealth_v5i3e14227_app1.png](#)]

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Abbreviations

CDC: Centers for Disease Control and Prevention
DEDC: Department of Epidemiology and Disease Control
FBDO: foodborne disease outbreak
FETP: Field Epidemiology Training Program
OR: odds ratio

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Original Paper

Risk Factors for End-Stage Renal Failure Among Patients on Hemodialysis in Aljomhory Hospital, Sa'adah Governorate, Yemen: Hospital-Based Case-Control Study

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Abstract

Background: More than 16% of the world's population is affected by chronic kidney disease, and these people are at the highest risk of developing end-stage renal failure (ESRF).

Objective: The aim of this study was to determine the risk factors of ESRF in Sa'adah Governorate in Yemen.

Methods: A hospital-based case-control study (86 cases and 263 controls) was conducted in the Aljomhory Hemodialysis Center in Sa'adah city, Yemen. Patients with ESRF who attended the hemodialysis center in Aljomhory Hospital in Sa'adah City from January 1 to February 15, 2016, were included. Control participants were healthy persons without end-stage renal disease (ESRD) who attended Aljomhory Hospital as outpatients' relatives during the study period.

Results: A total of 86 cases and 263 controls were included in this study. The mean age was 43.3 (SD 17.7) years for cases and 32.3 (SD 13.0) years for controls. In univariate analysis of factors associated with ESRD, patients aged ≥ 40 years were 3.7 times more likely to have ESRD than younger patients. The odds of ESRD was higher among men than women. Illiteracy was significantly associated with higher odds of ESRD. Hypertension (odds ratio [OR]=8.34), diabetes (OR=3.07), cardiovascular diseases (OR=12.71), presence of urinary stones (OR=21.87), recurrent urinary tract infection (OR=9.64), cigarette smoking (OR=2.44), and shammah use (OR=6.65) were significantly associated with higher odds of ESRD. Hypertension (OR=6.68), urinary stones (OR=16.08), and recurrent urinary tract infection (OR=8.75) remained significantly associated with ERD in multivariate analysis.

Conclusions: Hypertension, presence of urinary stones, and recurrent urinary tract infections were significantly associated with ESRF development. Improving the management of hypertension and designing suitable interventions to control problems of the urinary tract would help reduce ESRD prevalence.

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KEYWORDS

renal failure; end-stage renal failure; risk factors; case-control study; Yemen

Introduction

Chronic renal failure (CRF) or end-stage renal failure (ESRF) is defined as a permanent reduction in the glomerular filtration rate (GFR), sufficient to produce detectable alterations in the patient's wellbeing and organ function [1]. ESRF is defined as a GFR < 15 mL/min/1.73 m² or very high albuminuria (>300 mg

albumin/24 h) [2,3]. Up to 16% of the adult population internationally are affected by chronic kidney disease (CKD) [4]. More than 1.4 million patients are receiving renal replacement therapy (RRT) globally, with the annual incidence rate reaching 8% [3]. Kidney disease is the ninth leading cause of death in the United States [5]. High end-stage renal disease (ESRD) prevalence rates have been reported in many countries worldwide [6-8].

In 2006, the average incidence rate of ESRD in 10 countries in the Eastern Mediterranean Region, including Yemen, was 93 patients per million people [9]. The lowest prevalence was in Kuwait, with 80 patients per million people, and the highest was in Saudi Arabia and Yemen, with 462 and 320 patients per million people, respectively. Diabetes mellitus was the most frequently reported cause of ESRD in almost all countries, accounting for 20%–40% of the cases, followed by hypertension (accounting for 11%–30%) and glomerulonephritis (accounting for 11%–24%) [9].

CRF is a growing problem in Yemen. Between January 1998 and December 2002, 547 patients were admitted to the Science & Technology University Hospital, Sana'a (the capital city) including children with acute renal failure and CRF. CRF was observed in 400 patients, with an incidence of 64 per million people per year and a prevalence of 320 per million people. Acute renal failure occurred in 147 persons, with an incidence of 23.5 per million per year and a prevalence of 117.5 patients per million people. Of all patients, 72% were adults (age range, 20–60 years) with a male preponderance. As Yemen is a tropical country, malaria (27.9%), diarrhea (13.6%), and other infectious diseases were the main causes of renal failure [10]. The incidence might probably be higher in other governorates in Yemen, such as Hodeidah, because of the high prevalence of malaria, schistosomiasis, and renal stones and a low socioeconomic status [10]. In Yemen, the mortality was high in patients with malaria and those with associated hepatocellular failure [11]. The aim of this study was to determine the risk factors of ESRF in Sa'adah Governorate in Yemen.

Methods

This was a hospital-based case-control study. Cases include both previously and newly diagnosed ESRD patients who attended the hemodialysis center in Aljomhory Hospital in Sa'adah City during the study period, from January 1 to February 15, 2016. Control participants were healthy persons without ESRD who attended Aljomhory Hospital as outpatients' relatives during the study period. All cases were included, and systematic random selection of controls (a third person was involved to enable the researcher to complete interviews of each

person) was performed. The sample size was calculated using Open Epi (version 3.0, Centers for Disease Control and Prevention, Atlanta, Georgia) with 95% CI and 80% power. Using a case-to-control ratio of approximately 1:3, the sample size to detect an association with an odds ratio (OR) of 2 between any exposure and ESRD was estimated as 349 participants.

ESRF was defined according to the American National Kidney Foundation Definition (GFR < 15 mL/min/1.73 m²) or very high albuminuria (>300 mg/24 h) or as a serum creatinine level >3 mg/dL [12]. Data were collected using face-to-face interviews and a structured questionnaire. The questionnaire included questions about demographic characteristics, medical history, and family history.

Ethical clearance was obtained from the Ethics Committee in the Ministry of Public Health and Population prior to data collection. Participation in the study was voluntary. Data were entered and analyzed using Epi Info (Centers for Disease Control and Prevention, Atlanta, Georgia). A Chi-square test was used to compare the percentages, and an independent *t* test was used to compare means. Binary logistic regression was used to determine the factors associated with ESRF. A *P* value < .05 was considered statistically significant.

Results

A total of 86 cases and 263 controls were included in this study. The mean age was 43.3 (SD 17.7) years for cases and 32.3 (SD 13.0) years for controls. The highest proportion of ESRF in our study was observed in the age group of ≥60 years, constituting 29.1% of the cases. Table 1 shows the sociodemographic, clinical, and relevant characteristics of patients and controls. Almost half of the cases (n=46, 53.5%) and controls (n=62, 23.6%) were aged ≥40 years. About 39 (45.3%) cases and 161 (61.2%) controls were female. The proportion of hypertension was significantly higher among cases than among controls (48.8% vs 10.3%, *P* < .001). The cases were significantly more likely to have urinary stones (40.7% vs 3.0%, *P* < .001) and recurrent urinary tract infection (79.1% vs 28.1%, *P* < .001) than the controls.

Table 1. The sociodemographic, clinical, and relevant characteristics of patients and controls.

Characteristic	Cases, n (%)	Control, n (%)	P value
Age (year)			<.001
<40	40 (46.5)	201 (76.4)	
≥40	46 (53.5)	62 (23.6)	
Education			.005
Illiterate	57 (66.28)	126 (47.91)	
Literate	29 (33.72)	137 (52.09)	
Gender			.01
Male	47 (54.7)	102 (38.8)	
Female	39 (45.3)	161 (61.2)	
Presence of hypertension			<.001
Yes	42 (48.8)	27 (10.3)	
No	44 (51.2)	236 (89.7)	
Presence of diabetes mellitus			.011
Yes	11 (12.8)	12 (4.6)	
No	75 (87.2)	251 (95.4)	
Presence of cardiovascular diseases			<.001
Yes	11 (12.8)	3 (1.1)	
No	75 (87.2)	260 (98.9)	
Presence of urinary stones			<.001
Yes	35 (40.7)	8 (3.0)	
No	51 (59.3)	255 (97.0)	
Recurrent urinary tract infection			<.001
Yes	68 (79.1)	74 (28.1)	
No	18 (20.9)	189 (71.9)	
Cigarette smoking			.005
Yes	24 (27.9)	36 (13.7)	
No	62 (72.1)	227 (86.3)	
Shammah use			<.001
Yes	14 (16.3)	8 (3.0)	
No	72 (83.7)	255 (97.0)	

Table 2 shows the univariate and multivariate analyses of factors associated with ESRD.

In the univariate analysis of factors associated with ESRD, cases were significantly more likely to be illiterate than controls, and patients aged ≥40 years were 3.7 times more likely to have ESRD than younger patients. Patients of male gender had significantly higher odds of developing ESRD compared to those of female gender. Illiteracy was significantly associated with ESRD. Hypertension (OR=14.13), diabetes (OR=3.07),

cardiovascular disease (OR=10.24), presence of urinary stones (OR=24.76), recurrent urinary tract infection (OR=14.13), cigarette smoking (OR=7.39), and shammah use (OR=6.65) were significantly associated with higher odds of developing ESRD.

In multivariate analysis, hypertension (OR=6.7), presence of urinary stones (OR=16.1), and recurrent urinary tract infection (OR=8.7) were the only factors associated with ESRD after adjusting for other variables.

Table 2. Univariate and multivariate analysis of factors associated with end-stage renal disease.

Factor	Univariate analysis		Multivariate analysis	
	OR ^a (95% CI)	P value	OR (95% CI)	P value
Age (≥40 vs <40 years)	2.24 (3.73-6.21)	<.001	2.2 (0.91-5.34)	.08
Education (illiterate vs literate)	1.58 (0.97-2.6)	<.001	1.1 (0.45-2.50)	.87
Gender (male vs female)	1.9 (1.16-3.1)	.01	1.7 (0.75-3.87)	.20
Hypertension (yes vs no)	8.34 (4.67-14.91)	<.001	6.7 (2.7-16.4)	<.001
Diabetes mellitus (yes vs no)	3.07 (1.03-7.23)	.012	0.56 (0.14-2.21)	.39
Cardiovascular disease (yes vs no)	12.71 (3.45-47)	<.001	3.6 (0.8-17.3)	.10
Urinary stones (yes vs no)	21.87 (9.58-50)	<.001	16.1 (5.7-45.4)	<.001
Recurrent urinary tract infection (yes vs no)	9.64 (5.37-17.13)	<.001	8.7 (4.2-18.3)	<.001
Cigarette smoking (yes vs no)	2.44 (1.35-4.39)	.005	1.0 (0.39-2.65)	.96
Shammah use (yes vs no)	6.19 (2.5-15.34)	<.001	2.2 (0.50-9.33)	.30

^aOR: odds ratio.

Discussion

The highest proportion of ESRF in our study was observed in the age group of >60 years, which is similar to the data reported in the United States Renal Data System 2012 Annual Data Report Atlas of ESRD, which showed a predominance of ESRF among people above the age of 60 years [6]. In addition, our findings are in agreement with those of other case-control studies in which the mean age for patients with ESRF was 64 years. Other studies have also reported similar mean ages for patients with ESRF [3,12].

There was a slightly higher percentage of men among the cases in our study (55%). A study in Ivory Coast showed that male patients with ESRD constituted 61% of the study population [1]. In a case-control study conducted in Saudi Arabia and Egypt, male ESRD patients constituted 65% [13] and 61% [14] of the study population, respectively.

Illiteracy was associated with an increased odds of ESRF in our study. This finding is similar to that reported in a case-control study conducted in Taiwan, which reported a strong association between illiteracy and ESRF (OR=2.78, 95% CI 1.49-5.19) [15].

Hypertension and diabetes mellitus were associated with ESRF in our study. A case-control study conducted in Taiwan showed a similar significant association between ESRF and hypertension

(OR=4.23, 95% CI 2.51-7.13) as well as ESRF and diabetes mellitus (OR=7.45, 95% CI 3.54-15.53) [15]. Another case-control study conducted in Gujrat, Pakistan, found that hypertension is associated with ESRF (OR=15.16, 95% CI 7.116-32.324) and diabetes mellitus (OR 11.2, 95% CI 5.337-23.620) [16]. The same finding was reported in Arar City, Saudi Arabia, wherein hypertension (OR=6.17) and diabetes mellitus (OR=2.14) were associated with ESRF [17].

In agreement with other studies' findings [17,18], our findings showed that there is significant association between cardiovascular diseases and ESRF. We also noted that kidney or urinary tract stones were potentially associated with ESRF development. This finding was reported in other studies as well [19,20]. Regarding the strong association of recurrent kidney or urinary tract infection and ESRF, our findings are in agreement with those of other studies conducted in Pakistan [16] and Saudi Arabia [15].

Unlike many studies [21-24], this study showed no association between frequent analgesic intake and ESRF. Regarding the use of tobacco, our findings are similar to the findings of several studies that indicate that tobacco use (cigarette smoking) is considered a risk factor for ESRF [14,19,25,26].

In conclusion, hypertension, recurrent urinary tract infection, urolithiasis, family history of ESRF, and diabetes mellitus were potential risk factors for ESRD in the Yemeni community.

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Conflicts of Interest

None declared.

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Abbreviations

CKD: chronic kidney disease
CRF: chronic renal failure
ESRF: end-stage renal failure
ESRD: end-stage renal disease
GFR: glomerular filtration rate
OR: odds ratio

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Original Paper

Evaluation of the Acute Flaccid Paralysis Surveillance System in Polio-Free Jordan, 2012-2016: Retrospective Secondary Analysis

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Abstract

Background: As part of the polio-eradication strategy, the World Health Organization (WHO) has established a global acute flaccid paralysis (AFP) surveillance system. AFP surveillance has successfully helped Jordan achieve polio-free certification. However, there is a substantial risk of polio importation from neighboring countries including Syria and Iraq.

Objective: This study aimed to evaluate the AFP surveillance in Jordan and identify areas that need improvement.

Methods: This retrospective study is a secondary analysis of data that were routinely collected between 2012 and 2016 by Jordan's Expanded Program on Immunization. The WHO's minimum performance indicators were used to evaluate the AFP surveillance.

Results: Cumulatively, 328 AFP cases had been reported. Almost half (n=168, 51.3%) of the patients were aged 1-5 years, and 55.8% (n=183) were male. All cases were discarded (classified as a nonpolio case). The most common cause of AFP was Guillain-Barre Syndrome (n=115, 35.1%). The annualized nonpolio AFP rate increased from 1.4/100,000 children below 15 years of age in 2012 to 4.3 in 2016. National and subnational sensitivities were not met in 2012 and 2013. Adequacy of stool specimens and timeliness of specimens arriving at and processed in the laboratory were constantly above the minimum target. Timeliness of the investigation met the expected target but with a decreasing trend. The nonpolio enterovirus isolation rate was below the target, except in 2016.

Conclusions: The AFP surveillance system in Jordan is performing well; however, additional efforts are needed to strengthen the subnational sensitivity. The cold chain from sample collection to laboratory testing has to be maintained to ensure the reliability of stool specimens required for isolation of the nonpolio enterovirus.

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KEYWORDS

polio eradication; acute flaccid paralysis; surveillance; evaluation; Jordan; JFETP

Introduction

In 1988, the 41st World Health Assembly adopted the Global Polio Eradication Initiative [1]. Since then, the number of

poliomyelitis cases has decreased by over 99% in more than 125 endemic countries [2]. Four World Health Organization (WHO) regions—America, Western Pacific, Europe, and South-East Asia—were certified as polio-free in 1994, 2000,

2002, and 2014, respectively, and the disease was confined to three endemic countries (Nigeria, Pakistan, and Afghanistan) in 2014 [2]. Key strategies used by the Global Polio Eradication Initiative included strengthening childhood immunization through oral polio vaccines, conducting surveillance through investigation of AFP cases among children under 15 years of age, and conducting house-to-house “mop up” campaigns in areas where cases of polio have been identified [1,3].

Poliomyelitis is a highly contagious viral disease caused by any of three serotypes of the poliovirus, which belongs to the genus *Enterovirus* [4]. The virus is transmitted via the fecal-oral route, and humans are the only reservoir of the poliovirus. The virus affects mostly children under the age of 5 years. One of every 200 poliovirus infections results in clinically apparent paralytic disease. There is no cure for poliomyelitis; it can only be prevented via safe polio vaccination [2,4].

Acute flaccid paralysis (AFP) is defined as the sudden onset of weakness or paralysis of a limb, characterized as flaccidity (reduced tone), in a child younger than 15 years of age [5]. It is a complex clinical syndrome with several different etiologies including paralytic polio caused by wild poliovirus or circulating vaccine-derived poliovirus, Guillian-Barre syndrome (GBS), transverse myelitis, traumatic neuritis, meningitis, encephalitis, and brain tumors [6]. AFP surveillance includes detection and investigation of new-onset flaccid paralysis among children younger than 15 years of age or any other suspected poliomyelitis case among people of any age. It has been adopted globally as an essential strategy for monitoring the progress of the polio eradication initiative [7]. Nationwide AFP surveillance is essential to timely detect paralytic poliomyelitis due to wild poliovirus, to respond effectively to interrupt poliovirus transmission, to help monitor progress in polio eradication when polio exists in a country, to reveal the need of supplemental immunization activities, and to certify the absence of wild poliovirus circulation in countries with a polio-free status [7].

In Jordan, routine immunization against polio has been mandatory since 1979. The Polio Eradication Program led by the Jordan's Expanded Program on Immunization (EPI) and endorsed by the WHO has successfully contributed to the decrease in poliomyelitis cases throughout the country and played a considerable role in attaining WHO polio-free certification for Jordan. Jordan reported the last indigenous polio case in 1988, although the last virologically confirmed polio case was reported on March 3, 1992, with the probable origin of the virus from Pakistan [8]. The EPI in Jordan has routinely collected AFP surveillance data since 1999 [9].

Polio outbreaks continue to occur in some countries [7]. Jordan is a neighboring country of Syria and embraces Syrian refugees. As such, it remains at risk of importation of polio, and it is the right time to evaluate the AFP surveillance activities to ensure that AFP surveillance is implemented with the required standards. Therefore, this study aimed to evaluate AFP surveillance in Jordan and describe its indicators according to WHO in 2012-2016 and to identify limitations and areas that need further improvement to maintain the polio-free status.

Methods

Study Design

This study was based on a secondary analysis of AFP surveillance data that were routinely collected between 2012 and 2016 by the EPI. All AFP cases reported to the EPI from all the 12 governorates and all health sectors during this period were included. In this study, the AFP case investigation form, laboratory investigation form, sample results, and 60-day follow-up data were evaluated. The WHO's minimum performance indicators were used to evaluate the quality of AFP surveillance [5]. Official approval to conduct the study was obtained from the Ethical Committee at Jordan Ministry of Health.

The Acute Flaccid Paralysis Surveillance System in Jordan

Jordan is divided into 12 governorates and 21 districts; the health system is represented in five health sectors: Ministry of Health, Royal Medical Services, Private Sector, Teaching Hospitals, and United Nations Relief and Works Agency. Approximately 37.3% of the population is under 15 years of age.

In the AFP surveillance system in Jordan, an AFP case is defined as any child below the age of 15 years who develops acute onset of flaccid paralysis (including GBS, transverse myelitis, or any other cause) or any suspected case of polio at any age [9]. Since October 2014, the WHO in Jordan has ensured that all AFP cases are notified and investigated as prospective polio cases immediately by a special team (WHO AFP medical officers), maintaining timeliness and completeness as advised by the WHO. When a patient meets the AFP case definition, the health care practitioners immediately notify (by telephone) the local public health officer who, with the assistance of the WHO AFP officer, conducts a comprehensive investigation using the standard WHO case investigation form that includes demographic information, clinical history, vaccination history, adequacy and time of stool specimen collection, and preliminary diagnosis. The public health officer also ensures collection of two stool specimens, 24-48 hours apart, within 14 days of symptom onset. The case investigation report is then sent to the EPI.

Active surveillance is conducted by the local public health officers once a week, and the WHO AFP officers follow a predefined schedule (3-4 times a week) to cover public and private sectors.

Laboratory Investigation

Jordan's national poliovirus laboratory in Amman is a WHO-accredited laboratory of the Eastern Mediterranean Region poliovirus laboratories network. It has routinely registered epidemiological and virological data from AFP surveillance since 1998 [9]. Jordan's national poliovirus laboratory is equipped to isolate poliovirus from stool samples, identify poliovirus to confirm wild variety or circulating vaccine-derived poliovirus, and fulfill the examination of more than 150 contacts samples yearly. The collected specimens are sent to the WHO-accredited poliovirus isolation laboratory at the National central laboratory for enterovirus analysis. When

there is a suspicion of polio, the sample is referred to the regional WHO-accredited laboratory to confirm the result and differentiate between the three poliovirus serotypes.

Final Classification of Acute Flaccid Paralysis Cases

AFP classification in Jordan follows the WHO flow chart. An AFP case where two adequate stool specimens are analyzed and no poliovirus is isolated is classified as a nonpolio case (discarded). A case where the stool specimens are inadequate but the patient has no residual paralysis after 60 days of onset of symptoms is also classified as a nonpolio case (discarded). A case with inadequate stool specimens and residual paralysis after 60 days or one where the patient is lost to follow-up or dies within 60 days of symptom onset is referred to the National Polio Expert Committee for final classification (compatible with polio or should be discarded).

Environmental Surveillance

The sampling and testing of sewage can identify poliovirus circulation in populations serviced by the sewage system and are used to complement AFP surveillance [9]. Environmental surveillance has been established in Jordan in November 2016 (Currently, three sites in three governorates including at Zaatari camp, one governorate at the Syrian borderline, and the Amman governorate [most populated]) [9].

Data Analysis

Data were analyzed using a data management system for AFP surveillance data—Information for Action (Version 4. Geneva, Switzerland: World Health Organization) and Excel 2010

(Redmond, WA: Microsoft Corp). Descriptive analysis was used to describe the epidemiology of AFP in Jordan and to calculate statistics based on the standard WHO performance indicators for AFP surveillance.

Results

Overview

Cumulatively, 328 AFP cases were reported to the EPI between January 2012 and December 2016. There were two hot cases: one in Balqa governorate in 2012 and another in Mafrak in 2013. All cases were discarded. Of all cases, 168 (51.3%) were of patients between the ages of 1 and 5 years, and 183 (55.8%) were male. Almost half (163, 49.7%) of all cases had fever, 108 cases (32.9%) had asymmetric paralysis, and 113 cases (34.5%) had rapid progression of paralysis (Table 1). Of all cases, 292 (89.0%) had known polio immunization status. Figure 1 shows the immunity profile of AFP cases by year. Vaccination coverage of more than seven doses of oral polio vaccine was as high as 77.1% (n=253) of all AFP cases reported (Figure 1).

Classification of Acute Flaccid Paralysis Cases

The AFP cases were classified according to the WHO virological classification flowchart (Figure 2). A total of 13 cases (4%) had inadequate specimens and were reviewed by the National Polio Expert Committee (NPEC) who classified them as “discarded.” A variety of diagnoses were identified as causes of AFP. The most common causes were GBS (115, 35.1%), myositis (49, 14.9%), encephalitis (14, 4.3%), and transverse myelitis (14, 4.3%).

Table 1. Descriptive epidemiology of 328 acute flaccid paralysis cases reported in Jordan between January 2012 and December 2016.

Characteristic	Value, n (%)
Sex	
Male	183 (55.8)
Female	145 (44.2)
Age (years)	
<1	34 (10.4)
1-5	168 (51.3)
6-10	88 (26.8)
11-15	38 (11.5)
Clinical symptoms	
Fever	163 (49.7)
Asymmetric paralysis	108 (32.9)
Rapid progression of paralysis	113 (34.5)

Figure 1. Percentage of polio-vaccinated acute flaccid paralysis cases in Jordan between January 2012 and December 2016.

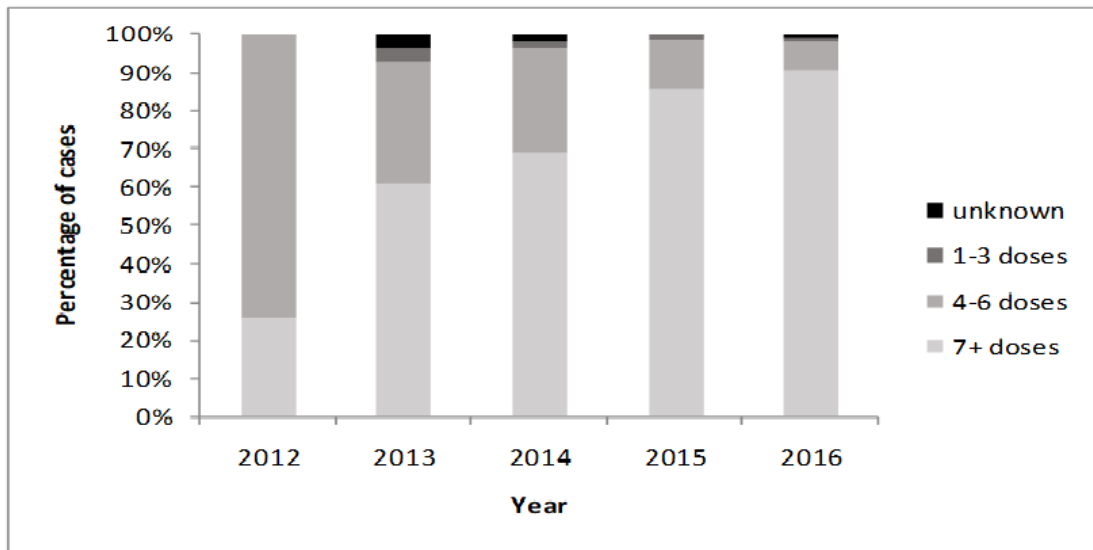
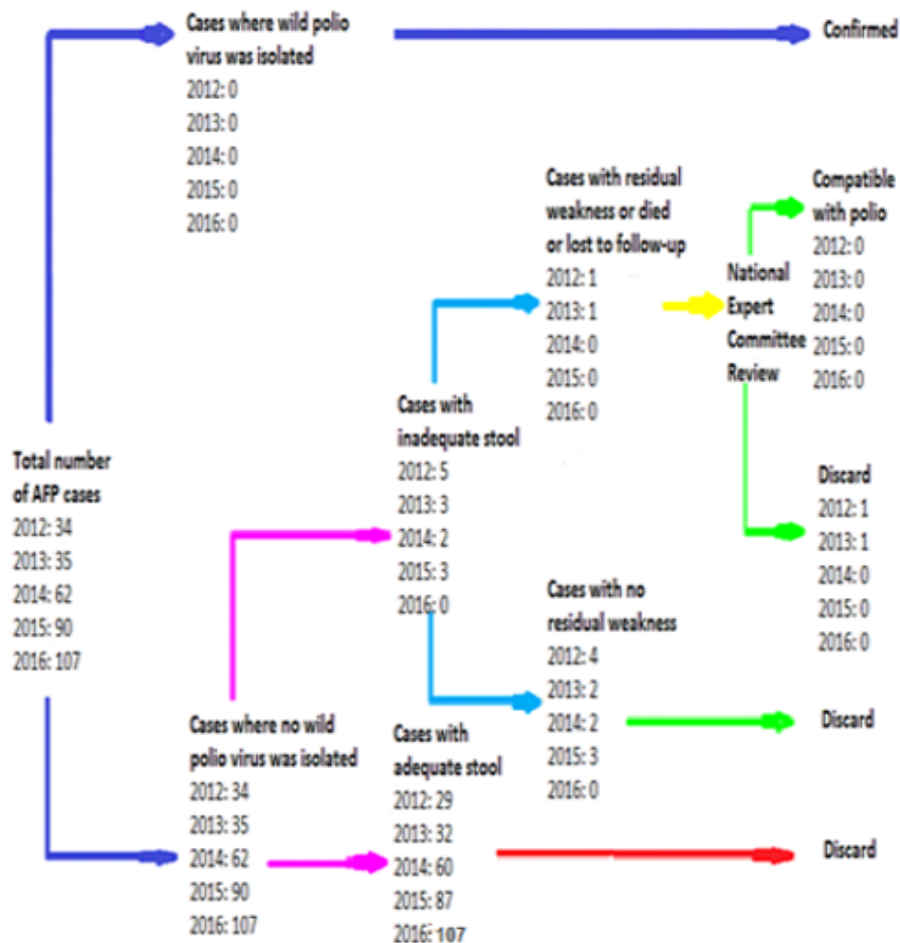


Figure 2. Flow chart showing the virological classification of AFP cases reported in Jordan between 2012 and 2016.



Evaluation Outcomes

Jordan’s cumulative annualized nonpolio AFP rate was 2.5 AFP cases per 100,000 people below the age of 15 years per year in 2012-2016. The country’s AFP incidence rate increased from 1.4 cases in 2012 to 4.3 cases per 100,000 people below the age of 15 years in 2016 (Table 2). Analyzing AFP rates by

governorate showed that during 2014-2016, all governorates fulfill the expected rate except three (Karak, Maan, and Madaba), which were silent in 2014, and the majority of governorates failed to consistently surpass the WHO minimum target of 2 AFP cases per 100,000 people under the age of 15 years in 2012 and 2013 (Table 3).

Table 2. Acute flaccid paralysis surveillance performance indicators for Jordan, 2012-2016.

Indicators of surveillance performance	Target	Country performance by year				
		2012	2013	2014	2015	2016
Percentage of all expected monthly reports received	≥90	100	100	100	100	100
Annualized nonpolio AFP ^a rate per 100,000 children under 15 years of age	≥2	1.4	1.4	2.3	3.2	4.3
Percentage of AFP cases investigated within 48 hours	≥80	100	100	98	98	95
Percentage of AFP cases with two adequate stool specimens collected 24-48 hours apart and ≤14 days after onset	≥80	85	91	97	97	100
Percentage of specimens arriving at the laboratory in good condition	≥80	100	100	100	100	100
Percentage of specimens arriving at a WHO-accredited laboratory within 3 days of being sent	≥80	100	97.1	95.2	94.4	98.6
Percentage of specimens for which laboratory results were sent within 28 days of receipt of specimens	≥80	97	100	100	100	96
Nonpolio enterovirus isolation rate of stool specimens submitted to the laboratory having nonpolio enterovirus isolated (%)	≥10	3	6	6	6	10
Percentage of AFP cases requiring a follow-up examination that were examined at 60 days after the onset of paralysis	≥80	94	94	97	90	95

Table 3. Incidence rate of annualized nonpolio acute flaccid paralysis per 100,000 children below the age of 15 years per year and governorate in Jordan in 2012-2016. The World Health Organization minimum target is ≥2 cases.

Governorate	2012	2013	2014	2015	2016
Ajloun	1.7	0.0	4.9	3.2	4.0
Amman	1.5	1.6	2.6	2.0	3.0
Aqaba	2.0	0.0	1.9	4.2	5.0
Balqa	0.6	1.3	1.8	3.0	3.3
Irbid	1.2	1.8	3.1	2.0	2.2
Jarash	2.6	1.3	3.7	5.7	4.7
Karak	3.2	1.2	0.0	4.0	5.7
Maan	2.1	0.0	0.0	4.3	7.4
Madaba	0.0	1.6	0.0	2.1	3.3
Mafrak	0.8	3.3	3.1	3.0	4.1
Tafleh	0.0	2.6	5.0	3.3	6.1
Zarqa	1.6	1.6	2.0	2.1	2.7

Table 2 shows the AFP surveillance performance indicators for Jordan in 2012-2016. The percentage of AFP cases with two adequate stool specimens was constantly above the minimum target of ≥80% in all governorates and reached 100% in 2016. The percentages of specimens arriving at the laboratory within 3 days of being sent were constantly above the WHO minimum target of at least 80%. The proportions of specimens processed in the laboratory within 28 days of specimens receipt were above the WHO minimum target of at least 80% during the time period study. More than 90% of the 328 AFP cases reported were investigated within 48 hours of being notified, which is above the WHO minimum target of at least 80%. The proportion of patients notified within 7 days of onset of symptoms was above 80%. All AFP cases requiring 60-day follow-up were examined at 60 days of onset of symptoms, reaching the expected target. The proportions of stool specimens where nonpolio enterovirus

was isolated were below the WHO minimum target of at least 10%, except in 2016 when it reached the target; however, these proportions increased from 3% in 2012 to 6% in 2013, 2014, and 2015.

Discussion

Principal Findings

This study evaluated the Jordan AFP surveillance performance over a 5-year period (2012-2016). Jordan is one of the many countries to attain polio-free certification. This study showed that there was no wild poliovirus isolated or any compatible case classified by the NPEC. However, importation of poliovirus remains a potential threat; therefore, it is essential to continue AFP surveillance. The study reported that half of the reported cases were of patients below 5 years of age, which is consistent

with findings of a study conducted in Iran [10] and another one in Bangladesh [11]. However, higher percentages were reported in countries such as Congo (85.2%) [12] and Ghana (74.4%) [13], and lower percentages were reported in other countries including Italy (37%) [14]. Of all cases, the number of boys exceeded the number of girls, a finding also reported in other studies [11,13,14].

Almost half of the patients (49.7%) had fever, and approximately one-third of the patients had asymmetric paralysis. This finding is similar to that in Iran [10]. Odoom et al [13] reported that 84.2% of cases had fever and 64.8% had asymmetric paralysis, and another study in Turkey reported that 13.6% of the total cases had fever [15].

Vaccination coverage of more than seven doses of oral polio vaccine was as high as 77.1% of all AFP cases reported. This impressive vaccination coverage is explained by the repetitive campaigns conducted in 2013-2016 that targeted prevention of polio importation from Syrian refugees and the high awareness of parents to ensure completion of the vaccination schedule and taking recommended doses during campaigns. A similar finding was revealed in Bangladesh (75%) [11]. In Turkey, 84.5% of the studied cases had at least one oral polio vaccine dose [15].

GBS was the most common cause of AFP and found in 35.1% cases in Jordan. A much higher rate (85.4%) was reported in a study in Iran [10]. In South Africa, in 2013, 42.7% of the AFP cases were caused by GBS [16]. In addition, >50% of AFP cases caused by GBS reflects the quality of AFP surveillance. Increased awareness of pediatricians and neurologists regarding the importance of reporting any suspected GBS will help identify a considerable number of AFP cases, since GBS was found to be the most common diagnosis of AFP in Jordan and other countries [12,17].

The sensitivity of the AFP surveillance system is reflected by the annualized nonpolio AFP rate. This study showed that the overall annualized nonpolio AFP rate (2.5/100,000 people below 15 years of age) exceeded the WHO target. Despite the increasing trend of the annualized nonpolio AFP rate over the 5-year study period, the AFP surveillance system failed to reach the minimum WHO requirement in 2012 and 2013. However, it is worth mentioning that Jordan performed well in fulfilling the WHO target in 2014, 2015, and 2016, with 2.3, 3.2, and 4.3 cases per 100,000 people below 15 years of age, respectively. This is explained by establishment of the WHO AFP officer team in 2014, which has since strengthened the active AFP surveillance. Subnationally, the annualized nonpolio AFP rate revealed that even in 2014, the expected target was not met for certain governorates (Karak, Maan, and Madaba) that were totally silent.

The percentage of AFP cases with two adequate stool specimens collected 24-48 hours apart and ≤ 14 days after onset is another surveillance performance indicator and should be $\geq 80\%$. Our study showed that Jordan performed well in meeting this target

constantly over the 5-year period, with an increasing trend up to 100% in 2016. This reflects the importance of the early detection of AFP cases. The timeliness of investigation of AFP cases reported exceeded the WHO target from 2012 to 2016. However, there is an alarmingly decreasing trend that can be explained by the increase of AFP cases and investigation over the study period. Jordan has to maintain the performance well over time, and therefore, there is a need for periodic sensitization of public health officers and the WHO AFP officer team with regard to the importance of maintaining the investigation of AFP cases within 48 hours. This study showed that all specimens that arrived at the laboratory were in good condition, but the results are combined with those of the stool specimen adequacy tests, as there were no separate data for the latter. The percentage of specimens arriving at a WHO-accredited laboratory within 3 days of being sent also reflects the timeliness of the process. The AFP surveillance system succeeded in achieving the expected WHO target from 2012 to 2016. Jordan's national poliovirus laboratory performed well in accomplishing the timeliness of AFP surveillance system; this may be due to the proximity and the centrality of Jordan's national poliovirus laboratory from the governorates and to the effort made by the EPI and the staff of the Jordan's national poliovirus laboratory. The evaluation of the viability of stool specimens sent to the laboratory is represented by the nonpolio enterovirus isolation rate, which should be at least 10% and was not achieved by the AFP surveillance system during the study period; this indicates that the reverse cold chain was not maintained in that period, except in 2016 where it was in line with the WHO target. A high nonpolio enterovirus isolation rate was reported in Ghana [13], Bangladesh [11], and Turkey [15]. More than 90% of the AFP cases reported during the study period and requiring 60-day follow-up examination had been examined at 60 days after the onset of paralysis, meeting the specified WHO target. Furthermore, when there is no need of the NPEC review, the EPI takes a simple random sample from the annual AFP cases to the NPEC to ensure that the AFP surveillance is functioning well.

Conclusions

The Jordan AFP surveillance system is performing well in meeting and exceeding the WHO targets. However, national performance can obscure the subnational performance and prevent early detection of AFP cases, which can occur at the district level. Therefore, subnational surveillance has to meet the WHO targets in a disaggregated way. Moreover, the cold chain from sample collection to laboratory testing has to be maintained to ensure the reliability of stool specimens required for the isolation of nonpolio enteroviruses. Environmental surveillance is another strategy for maintaining a polio-free status; Jordan has this strategy in place, but more areas need to be selected to cover the whole country. Sharing polio experiences between countries is advisable to meet the global polio eradication goals.

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Conflicts of Interest

None declared.

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Abbreviations

AFP: Acute Flaccid Paralysis

EPI: Expanded Program on Immunization

GBS: Guillain-Barre Syndrome

NPEC: National Polio Expert Committee

WHO: World Health Organization

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Original Paper

Using a Call Center to Reduce Harm From Self-Administration of Reproductive Health Medicines in Bangladesh: Interrupted Time-Series

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Abstract

Background: Annually, there are approximately 25 million unsafe abortions, and this remains a leading cause of maternal morbidity and mortality. In settings where abortion is restricted, women are increasingly able to self-manage abortions by purchasing abortion medications such as misoprostol and mifepristone (RU-486) from pharmacies or other drug sellers. Better availability of these drugs has been shown to be associated with reductions in complications from unsafe abortions. In Bangladesh, abortion is restricted; however, menstrual regulation (MR) was introduced in the 1970s as an interim method of preventing pregnancy. Pharmacy provision of medications for MR is widespread, but customers purchasing these drugs from pharmacies often do not have access to quality information on dosage and potential complications.

Objective: This study aimed to describe a call center intervention in Bangladesh, and assess call center use over time and how this changed when a new MR product (combined mifepristone-misoprostol) was introduced into the market.

Methods: In 2010, Marie Stopes Bangladesh established a care provider-assisted call center to reduce potential harm from self-administration of MR medications. The call center number was advertised widely in pharmacies and on MR product packaging. We conducted a secondary analysis of routine data collected by call center workers between July 2012 and August 2016. We investigated the reported types of callers, the reason for call, and reported usage of MR products before and after November 2014. We used an interrupted time series (ITS) analysis to formally assess levels of change in caller characteristics and reasons for calling.

Results: Over the 4-year period, 287,095 calls about MR were received and the number of users steadily increased over time. The most common callers (of 287,042 callers) were MR users (67,438, 23.49%), their husbands (65,999, 22.99%), pharmacy workers (65,828, 22.93%), and village doctors (56,036, 19.52%). Most MR calls were about misoprostol, but after November 2014, a growing proportion of calls were about the mifepristone-misoprostol regimen. The most common reasons (of 287,042 reasons) for calling were to obtain information about the regimen (208,605, 72.66%), to obtain information about side effects (208,267, 72.54%), or to report side effects (49,930, 17.39%). The ITS analyses showed that after November 2014, an increasing

number of calls were from MR users who had taken the complete regimen ($P=.02$ and who were calling to discuss reported side effects ($P=.01$) and pain medication ($P=.01$), and there were fewer calls asking about dosages ($P<.001$).

Conclusions: The high call volume suggests that this call center intervention addressed an unmet demand for information about MR medications from both MR users and health care providers. Call center interventions may improve the quality of information available by providing information directly to MR users and drug sellers, and thus reducing the potential harm from self-management of MR medications.

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KEYWORDS

reproductive health; call center; Bangladesh; menstrual regulation; abortion, induced; abortion, legal; health behavior; help-seeking behavior

Introduction

Background

The most recent estimates suggest that between 2010 and 2014, there were 56 million abortions annually, of which 25 million were unsafe [1]. Unsafe abortions are a leading cause of maternal morbidity and mortality and are particularly prevalent in low-income settings. In settings where abortion is restricted or difficult to access, women are increasingly able to self-manage abortions more safely by purchasing abortion medications such as misoprostol and mifepristone from pharmacies or other drug sellers [2,3]. The increasing availability of these medications is thought to have resulted in reduced morbidity from unsafe self-induced abortion in many low-income countries [4-6]. The World Health Organization's (WHO) guidance on health worker roles for safe abortion states that women can safely self-manage elements of medical abortion in circumstances where women have a source of accurate information and access to a health care provider should they need or want it [7]. However, women accessing these medications from pharmacies often do not receive adequate information from pharmacy workers because pharmacy staff lack knowledge about effective regimens and potential complications [2,3].

The increasing use of mobile and wireless technologies for health—known as mobile health (mHealth)—has huge potential to improve health systems in low- and middle-income countries (LMICs) through better access to knowledge and information [8]. mHealth approaches are being promoted in Bangladesh, where household mobile phone ownership has risen rapidly from 32% of households in 2007 to 89% in 2014 [9,10]. Call centers and hot lines can help to reduce geographic inequalities in health services and may be particularly appropriate for reproductive health issues because they can provide client anonymity when discussing sensitive matters. Recent studies have demonstrated the importance of hotlines for enabling women's access to information on safe abortion medications in legally restrictive settings such as Latin America and Indonesia [11,12], and safe abortion hotlines exist in more than 20 countries in the global South [13]. Furthermore, it has been shown that mHealth approaches (involving getting advice and support by phone or the internet) can be successfully used by women self-administering medical abortions [14]. However, it is recognized that more research is needed to understand exactly

how women use abortion hotlines for support and for what reasons [15].

The Context of Menstrual Regulation in Bangladesh

In Bangladesh, abortion is legal only to save a woman's life; however, menstrual regulation (MR), "an interim method of establishing non-pregnancy in women at risk of being pregnant," was introduced in the country in 1972 as a strategy to reduce morbidity and mortality from unsafe abortion [16]. Pregnancy is not confirmed before administering the procedure or medications. The approved methods for MR services are manual vacuum aspiration (MVA) up to 12 weeks after a missed period and, since 2013, administration of mifepristone and misoprostol up to 9 weeks [17]. In February 2013, the first combination pack of mifepristone-misoprostol (branded the MM Kit) was accepted by the National Drug Administration of Bangladesh and came onto the market as an alternative to surgical MR. A second brand, the MTP Kit, was approved and became available later in the year [18]. Self-induced MR with medication has also long been practiced in Bangladesh through off-label use of misoprostol, which is registered for use for postpartum hemorrhage and peptic ulcer, provided through pharmacies [19]. There is little regulation of pharmacies in Bangladesh, and many medications are sold over the counter without a prescription [20], including misoprostol and MR medications [19,21]. Since the registration of the combination pack of mifepristone-misoprostol, combination products as well as misoprostol alone have increasingly become available in pharmacies [21]. Information provided by the Directorate General of Drug Administration in Bangladesh shows that currently 32 brands of misoprostol only are registered for sale by 28 pharmaceutical companies, and the combination regimen is registered for sale by at least 8 different companies [22]. However, as seen in other countries, pharmacy and mystery client surveys conducted in Bangladesh have documented poor knowledge of effective regimens for medical MR among pharmacy workers [19,21,23]. This is particularly important, given that misoprostol is not registered for MR and does not contain instructions for use for this indication.

The most recent study of MR incidence in Bangladesh showed that in 2014, an estimated 430,000 MR procedures (using MVA or medication) were performed in health facilities nationwide, whereas an estimated 1,194,000 induced abortions occurred and 257,000 women were treated for complications from abortion [24]. Singh et al found that of the women presenting with postabortion complications, the proportion of women with

hemorrhage increased substantially between 2010 and 2014, from 27% to 48%, and the estimated proportion with incomplete abortion declined from 66% to 56% [24]. This is consistent with a pattern of increased use of misoprostol-induced abortion, in which heavy and prolonged bleeding is a common side effect. It is possible that this symptom would have resolved without further treatment for some women, but the trend suggests the need for improved access to information about correct use and potential side effects and complication management.

The Marie Stopes Bangladesh Call Center Initiative and Aims of the Study

Marie Stopes Bangladesh (MSB) is a sexual and reproductive health service provider, operating through 600 service delivery outlets across all 64 districts of Bangladesh, including static centers, outreach teams accessing hard-to-reach and underserved rural communities, public sector support, and social marketing channels. To address the lack of access to accurate information about MR medications, MSB set up a call center in 2010 with the goal of preventing potential harm for individuals who purchase MR medications from pharmacies and drug shops. This study uses routine data to investigate the changing use of the call center over a 4-year period (2012-2016). The objectives of the study were to (1) describe the characteristics of call center users and their reasons for calling and (2) assess whether the introduction of a mifepristone-misoprostol combined regimen into the market led to a change in the usage of the call center. It is hoped that the results can inform future programming for information provision about mifepristone and misoprostol in Bangladesh and other LMICs. The term pharmacy can refer to a range of businesses of various sizes and legal statuses, and in this paper, we refer to pharmacies and drug shops as any outlet whose business is selling medicines, regardless of their training, staff qualifications, or legal status. We refer to

mifepristone-misoprostol and misoprostol alone as *MR medications* for the remainder of the paper.

Methods

Details of the Call Center Initiative

This call center initiative is one of 27 reproductive health call centers supported by Marie Stopes International worldwide [25]. The call center provides a supplementary information service for MR users and is open 24 hours a day, 7 days a week. The call charge is at the rate of a regular call to a mobile phone, but callers can also request an immediate free callback. The call operators are all female, mid-level medical service providers who have completed a 36-month course from the Medical Assistant Training School. All operators receive in-house training covering counseling skills for MR and related reproductive health topics, MSB services, the use of medication for MR, management of side effects and complications, referring to the nearest private or public facility, and the legal status of MR. The operators are also trained to discuss contraceptive options with callers who have used or are intending to use medications for MR. Regular refresher training sessions are conducted for call operators. The quality of calls is routinely monitored using mystery callers. The call center number is widely promoted through a variety of channels; MSB distributes promotional stickers, wallet-sized cards, and posters through pharmacies and village doctors and promotes the call center verbally when attending pharmacies and during orientations of drug sellers and village doctors (eg, see [Figure 1](#)). In addition, the call center number was printed on the packaging and foil of 2 MSB products (one misoprostol only from 2012 and another combination pack [mifepristone-misoprostol] from 2014) and a non-MSB combination pack product from 2015.

Figure 1. Examples of call centre promotional materials.

Data

This study retrospectively analyzed routine data collected by MSB call center operators between July 2012 and August 2016. In June 2012, a 15-item monitoring form was designed to collect information on the profile of callers and their reasons for calling. All operators were trained to administer the questions from the monitoring form during every call, to record responses on paper during the call or immediately after, and to enter the data into an Epi Info 7 database (developed by the Centers for Disease Control and Prevention) between calls. No identifying information such as the caller's name or address was collected. Each caller was asked if they had called before but repeat callers are treated as distinct individuals and their records from previous calls are not matched. Data collection commenced in July 2012 and is ongoing.

Variables and Analysis

The variables in the monitoring form are as follows. Callers were asked about their location (one of several divisions of Bangladesh), the age range of the MR user (in 5-year groups), and whether they were a repeat caller (yes or no). Operators recorded the caller's relationship to the MR user with the following response options: pharmaceutical representative, pharmacist, pharmacy worker, village doctor, woman herself (MR user), husband, mother, and other relative or friend of MR user). All callers were asked the general reason for calling, and the call center operator could select multiple responses from a

list of 12 (including misoprostol for medical MR, misoprostol for other conditions, combination regimen for medical MR, family planning, other reproductive or general health questions, or information on the nearest clinic or hospital). If the call was MR related, the specific queries of the caller were recorded (including whether misoprostol can be used for medical MR, correct dosage for medical MR [timing, dosage, or route], questions about side effects and complications, experience of side effects, experience of complications, taken the wrong dose, pain medications, and accessing the clinic or hospital). If the reason for calling was that the end user was experiencing side effects or suspected complications, the types of side effects and suspected complications were recorded. Complications are reported as *suspected* because they were diagnosed remotely by the call center operator based on information given by the caller and may not be clinically accurate. MR-related callers were asked whether the MR drug had already been purchased, the brand purchased, and whether the end user had already taken the medication.

Some adaptations were made to the monitoring form after the initiation of data being recorded: the repeat caller variable was only included from July 2013, whether the MR drug had already been purchased was only available from November 2014, brand data were available only from September 2013, and under general reasons for calling, the response options *mifepristone-misoprostol combination pack*, *general health*, and *other reproductive health* were only available from November 2014. The analysis received ethical approval from

the Marie Stopes Independent Ethics Review Committee (012 - 15) and the Bangladesh Medical Research Council (803). The ethics committee approved our analysis of routine data without explicit consent from the participants to use their data for research purposes, for the following reasons: (1) the risks of identification of callers is minimal, especially as all data are presented in aggregate, (2) the data were not part of a research project but part of routine monitoring, and (3) the medications used were part of a national protocol rather than being introduced as part of the study.

Statistical Analysis

Use of the Call Center

We conducted descriptive analyses of the number of calls, profiles of call center users, and their reported reasons for calling over time, using aggregate monthly data.

Differences in Call Center Use

To assess whether the introduction of the combination regimen was associated with differences in call center use, we compared caller characteristics before and after November 2014. This month was chosen because it was when the call center number started to be printed on a combination pack, so although the combination regimen was available on the market from March 2013, the call center was unlikely to receive calls until the call center number was widely advertised through product packaging. Interrupted time series (ITS) analysis was used [26] to formally evaluate whether changes in the number of calls according to reason for calling and caller type had occurred after November 2014. We necessarily restricted the ITS to

outcomes that had complete data across the entire period. As MR combination regimen users receive more comprehensive dosage instructions from the packaging than MR misoprostol-only users, we hypothesized that the introduction of the combination regimen would result in a change in both the level and slope of the relationship between types of callers, reason for calling, and whether the MR user had taken the drug before calling in the pre- and postintervention periods. We conducted the ITS analysis using STATA 14.0 [27] using the STATA module ITSA: Stata module to perform ITS analysis for single and multiple groups [28].

Misoprostol-Only and Combination Regimen Callers

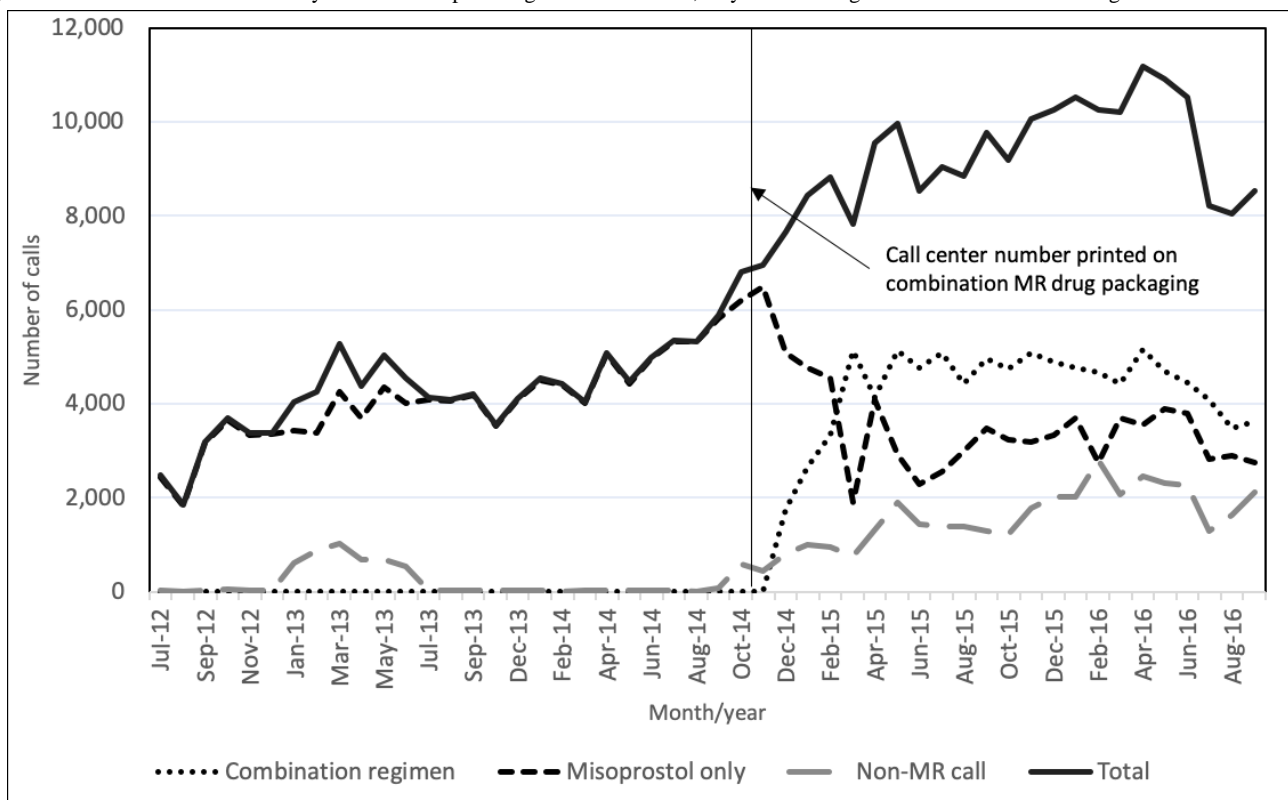
We also compared characteristics of calls related to misoprostol only and the combination pack using bivariate crosstabulations.

Results

Use of the Call Center

A total of 344,827 calls were made to the call center between July 2012 and August 2016, and the number of calls per month increased from 2778 in July 2012 to a peak of 11,157 calls in March 2016, falling to 8516 in August 2016 (Figure 2). Over the whole period studied, 83.25% of the calls were about MR (either misoprostol or combination regimen; n=287,095). Between July 2012 and October 2014, all MR calls were about misoprostol, but after the introduction of the call center number to a combination pack in November 2014, calls about the combination regimen grew rapidly and quickly overtook the number of calls about misoprostol only MR.

Figure 2. Number of calls received by the Marie Stopes Bangladesh call center, July 2012 to August 2016. MR: menstrual regulation.



The number and proportion of calls that were for non-MR queries also increased after November 2014, and by August 2016, they accounted for a quarter of all calls. Non-MR-related reasons for calling included questions about accessing the nearest clinic or hospital (28,554/344,827, 8.28%), family planning (6403/344,827, 3.10%), other reproductive or general health topics (7156/344,827, 3.47%), misoprostol for other indications (1518/344,827, 0.49%), and other reasons (21,114/344,827, 10.06%). Non-MR-related calls are excluded from the subsequent analysis.

Characteristics of Those Calling About Menstrual Regulation

The characteristics of MR-related calls are shown in [Table 1](#). Over half (163,018, 56.79%) of the 287,042 MR-related calls were made by MR users, their friends, or relatives: 67,438 (23.49%) from the MR user, 65,999 (22.99%) from their husbands, 17,115 (5.99%) from their mother or other relatives, and 12,446 (4.34%) from friends. Health care or medication providers represented 123,467 (43.01%) of calls, 65,828 (22.93%) were from pharmacists or pharmacy workers, 56,036 (19.52%) of calls were from village doctors, and a small number of calls (1603, 0.56%) were received from pharmaceutical representatives. Most calls (141,148, 49.17%) came from the two most populous divisions of Bangladesh, Dhaka and Chittagong. The majority of callers reported the MR user's age as being below 25 years.

Just under half of MR calls (110,635/250,814, 44.94%) were from repeat callers. We cross-tabulated repeat callers with other characteristics (results available on request) and found that

repeat callers were more likely to be MR users or pharmacy workers compared with calls from first-time callers, but there were no other significant differences in the characteristics of repeat callers and first-time callers. We also cross-tabulated the reason for calling with the type of caller, which showed that calls about misoprostol for indications other than MR (eg, related to postpartum hemorrhage) were more likely to be made by a provider (predominantly driven by calls from village doctors) than an MR user or their family.

Of 287,095 calls, 109,429 (64.50%) calls were made when the MR user had already purchased the drug, and 68,732 (23.95%) of the MR users had taken MR medications before calling. The most common MR-related reasons for calling were to ask if medications could be used for MR (161,145/169,453, 96.75%), to obtain regimen information (208,605/287,095, 72.66%), and to get information about side effects (208,267/287,095, 72.54%). Overall, 49,930 of 287,095 people (17.39%) called because they were experiencing side effects, 21,207 (7.39%, 21,207/218,738) called to ask about pain medication, 6745 (3.08%, 6745/218,738) suspected they had taken the wrong dose, and 11,207 (3.90%, 11,207/287,095) wanted information on accessing the nearest clinic or hospital. The most common side effects reported were cramps (7.26%) followed by bleeding (4.06%) and diarrhea (4.10%), fever (2.84%), and vomiting (1.14%; data not shown). In addition, 2.83% of MR callers said they thought they were experiencing complications, and almost all of these were suspected to have incomplete MR. Only 3 callers reported excessive blood loss. Most callers called for more than one reason.

Table 1. Characteristics of individuals calling the Marie Stopes Bangladesh call center about menstrual regulation (MR) from July 2012 to August 2016.

Characteristic of the call or caller	July 2012-October 2014, %	November 2014-August 2016, %	Total, n (%)	P value
Type of caller				<.001
Pharmaceutical representative	0.51	0.59	1603 (0.56)	
Pharmacist or pharmacy worker	21.83	23.70	65,828 (22.93)	
Village doctor	20.76	18.67	56,036 (19.52)	
MR user (woman)	21.70	24.74	67,438 (23.49)	
Husband of MR user	28.19	19.39	65,999 (22.99)	
Mother or other relative of MR user	4.08	7.27	17,115 (5.96)	
Friend of MR user	2.61	5.54	12,466 (4.34)	
Don't know, refuse and missing	0.33	0.10	557 (0.19)	
Reported age of MR user (years)				<.001
<20	20.20	25.85	67,579 (23.54)	
20-24	40.04	35.03	106,453 (37.08)	
25-29	25.67	21.18	66,074 (23.01)	
30 or older	9.24	14.35	35,188 (12.26)	
Don't know, refuse and missing	4.85	3.60	11,801 (4.11)	
Division of Bangladesh				<.001
Dhaka	28.47	27.27	79,700 (27.76)	
Rajshahi	10.72	12.54	33,870 (11.80)	
Rangpur	9.01	10.37	28,175 (9.81)	
Chittagong	22.21	20.84	61,448 (21.40)	
Sylhet	8.80	11.25	29,422 (10.25)	
Khulna	8.44	7.73	23,017 (8.02)	
Barisal	6.58	7.09	19,758 (6.88)	
Out of country, don't know, refuse and missing	5.76	2.91	11,705 (4.08)	
Repeat caller^a				<.001
Don't know and refuse	12.44	8.21	23,450 (9.53)	
Yes	45.69	44.61	110,635 (44.94)	
No	41.87	47.18	112,085 (45.53)	
MR user had purchased drug before calling^b				— ^c
Don't know and refuse	—	—	1070 (0.63)	
Yes	—	—	109,429 (64.50)	
No	—	—	59,158 (34.87)	
MR user had taken drug before calling				<.001
Taken complete regimen	12.38	17.80	44,745 (15.59)	
Started the regimen	10.17	7.10	23,987 (8.36)	
Not taken	72.78	72.35	208,211 (72.52)	
Don't know and other	4.67	2.75	10,152 (3.54)	
Specific MR-related query^d				
Whether misoprostol used for MR ^e	—	96.75	164,145 (96.75)	—
Correct MR dosage and regimen ^f	73.11	72.35	208,605 (72.66)	<.001

Characteristic of the call or caller	July 2012–October 2014, %	November 2014–August 2016, %	Total, n (%)	P value
Information on side effects and complications	72.82	72.35	208,267 (72.54)	<.001
Experiencing side effects	15.12	18.96	49,930 (17.39)	<.001
Caller suspects complications	2.04	3.37	8118 (2.83)	<.001
Caller thinks they have taken the wrong dose ^g	4.22	2.75	6745 (3.08)	<.001
Questions about taking pain medication	6.75	7.83	21,207 (7.39)	<.001
Questions about accessing clinic or hospital	1.04	5.88	11,207 (3.90)	<.001
Total	40.91	59.09	287,095 (100.00)	—

^aQuestion introduced in July 2013.

^bMissing data due to question being introduced in November 2014.

^cNot applicable.

^dMultiple responses allowed, so column percentages can total more than 100.

^eMissing data due to question being introduced in November 2014.

^fCombined responses to queries about timing, dosage, and route.

^gQuestion not asked in September 2013–October 2014.

Table 1 also compares the characteristics of callers before and after November 2014 when the call center number started to be printed on the combination pack. As expected, because of the large population size, all differences were statistically significant using the chi-square test. After November 2014, a larger proportion of calls were from pharmacy workers, MR users, and their relatives, whereas proportionally fewer calls were from MR users' husbands and village doctors. After November 2014, more callers reported taking the complete regimen before calling and proportionally more reported experiencing side effects, but these trends are likely linked.

Change in Call Center Use Over Time

The brands of MR medications reported to have been purchased by call center users varied over time, and details of the most commonly mentioned brands are shown in **Table 2**. **Figure 3** shows the number of calls by type and brand of MR drug over time, grouped by the brands in **Table 2**. Before November 2014, the callers were mainly using 2 brands of misoprostol. When the call center number was advertised on the packaging of a combination pack released into the market in November 2014, an increasing number of calls were related to this brand of the combination regimen (brand 2). In January 2015, the combination regimen brand 1 also began to advertise the call center number on its packaging (although the brand had been on the market since February 2013), and there was a corresponding increase in calls. The call center also received calls about products that do not have the call center number on

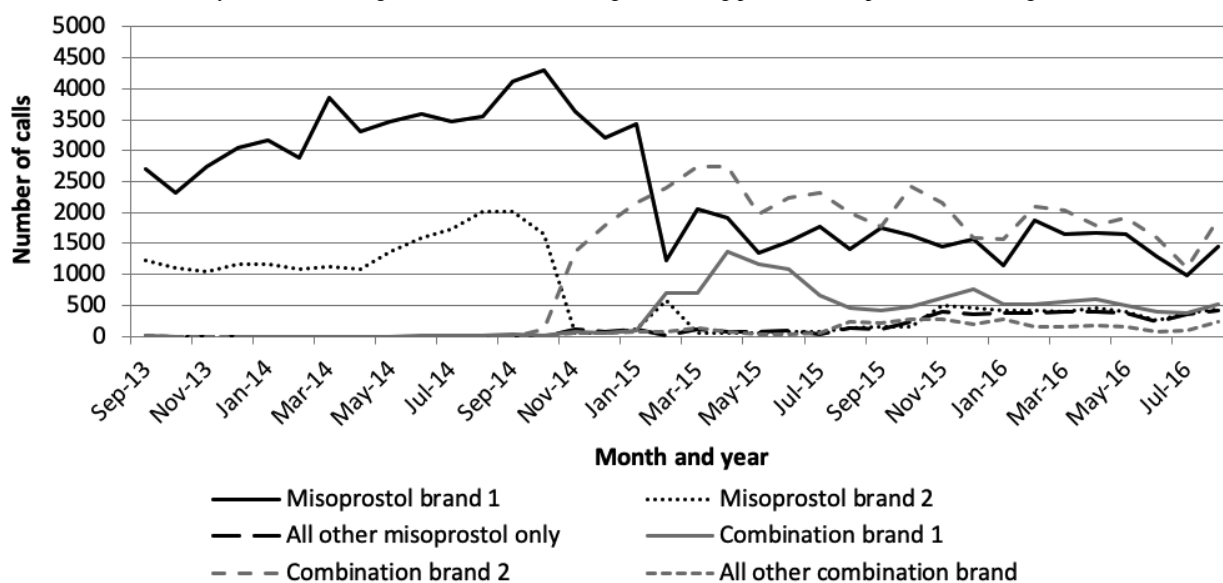
the packaging, reflecting the promotion of the call center through other channels including in-pharmacy posters and danglers.

Time series plots showed that over the 4-year reference period, the mean number of MR users who reported they were under 20 years increased. Over time, there was a steady decrease in calls from husbands of MR users, and slight increases in calls from MR users and pharmacists or pharmacy workers. There was a noticeable increase in the proportion of callers who reported having taken the complete regimen and decrease in those who had called the call center when they had only started the regimen.

ITS analyses using November 2014 as the intervention point are shown in **Table 3** as regression results and **Figure 4** as plots for selected outcomes (plots for all outcomes in **Table 3** available on request). **Table 3** shows that there were significant differences in the trends in the number of calls at November 2014 (the last column) related to several factors. After November 2014, an upward trend began in the number of calls where the user had taken the complete regimen, and likely related to this, there were similar post-November 2014 upward trends in calls concerning MR users experiencing side effects and enquiring about pain medication. There were downward trends post-November 2014 in the number of calls asking about dosage and regimen and asking for information on side effects. There were no significant trend changes in the caller age and types of callers and in the number of calls regarding suspected complications.

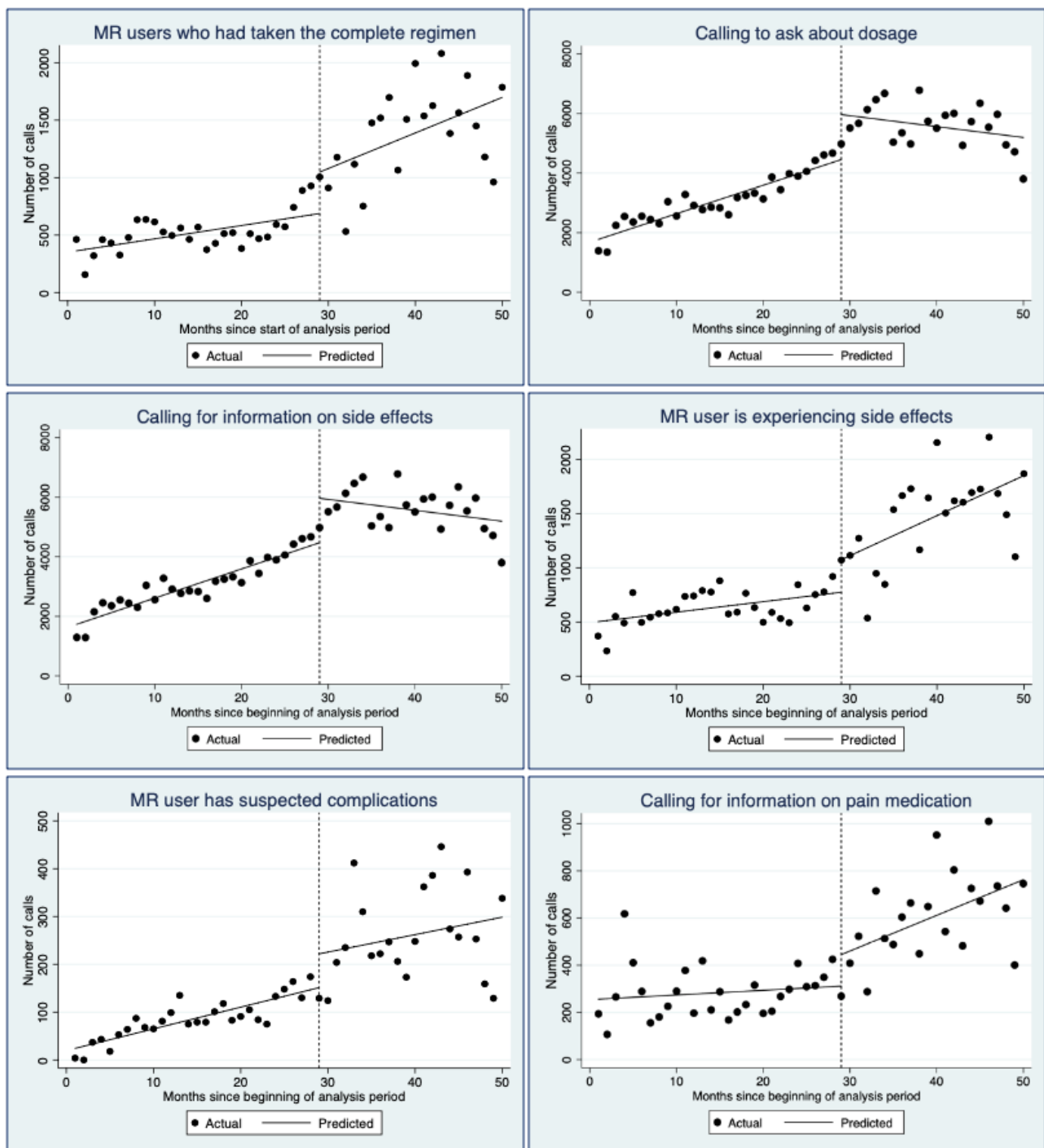
Table 2. Details of the most commonly mentioned menstrual regulation medications.

Product	Date registered in Bangladesh	Date call center number first printed on product
Misoprostol brand 1	September 2011	September 2011
Misoprostol brand 2	2002	Not printed
Combination brand 1	February 2013	January 2015
Combination brand 2	October 2014	October 2014

Figure 3. Number of calls by month according to brand of menstrual regulation drug purchased (September 2013-August 2016).**Table 3.** Interrupted time series regression results comparing the number of calls pre- and post-November 2014, overall, by type of caller, and reason for calling.

Characteristic of the call or caller	Mean calls per month at start of time series	Time trend (calls per month) before November 2014 (95% CI)	Step change at November 2014 (95% CI)	Change in time trend after November 2014 (95% CI)
Overall	2641.5	115.0 (87.3 to 142.8)	1866.6 (1064.5 to 2668.8)	-1.6 (-0.73 to 70.0)
Type of caller				
Pharmacist or pharmacy worker	352.2	41.7 (32.2 to 51.2)	277.5 (10.6 to 544.5)	2.8 (-15.5 to 21.2)
Menstrual regulation (MR) user (woman)	732.4	13.1 (-5.5 to 31.8)	632.7 (60.8 to 1204.8)	16.5 (-21.3 to 54.5)
Reported age of MR user (years)				
<20	362.7	35.8 (28.1 to 43.7)	391.8 (75.0 to 708.6)	22.3 (-2.8 to 47.4)
MR user had taken drug before call				
Taken complete regimen	362.7	11.6 (3.1 to 20.1)	360.8 (46.8 to 674.8)	30.9 (4.4 to 57.4)
Reason for calling about MR				
Correct MR dosage and regimen	1775.7	95.6 (77.2 to 114.0)	1510.5 (771.1 to 2250.0)	-36.9 (-96.8 to 23.7)
Information on side effects and complications	1733.8	97.8 (79.2 to 116.5)	1490.5 (754.2 to 2226.9)	-36.5 (-96.8 to 23.7)
Experiencing side effects	503.5	9.7 (2.4 to 16.9)	300.3 (-24.2 to 624.9)	36.9 (10.7 to 63.2)
Caller suspects complications	24.2	4.5 (3.4 to 5.7)	70.6 (-23.3 to 164.6)	3.7 (-4.3 to 11.6)
Questions about pain medication	256.2	2.0 (-4.8 to 8.8)	133.1 (-11.0 to 278.2)	15.1 (3.3 to 26.9)

Figure 4. Plotted time series data and fitted regression lines considering pre- and postintroduction of the combination regimen (November 14) for selected outcomes.



Misoprostol-Only and Combination Regimen Callers

Table 4 compares the characteristics and reasons for calling between callers who had purchased misoprostol-only versus the combination pack (data from November 2014 to August 2016). There was little difference in the age profile of the 2 types of callers. Combination pack callers were more likely to be MR users themselves (26.9% vs 22.0%) and less likely to be the husbands of MR users (18.0% vs 21.2%). Combination pack purchasers were more likely than misoprostol-only purchasers to call after taking the complete regimen (19.0% vs

16.3%), to have called for information about dose or timing (73.6% vs 70.8%), or to say they were experiencing side effects (19.6% vs 18.1%). Misoprostol-only callers were more likely to need information about pain medication (8.7% vs 7.2%), think they had taken the wrong dose (3.6% vs 2.1%), or need to access the clinic or hospital (7.1% vs 5.0%). Combination pack callers were more likely to call citing bleeding as a side effect (6.3% vs 2.8%), which may be because more had taken the complete regimen or may reflect underdosing of misoprostol only users.

Table 4. Differences between combination drug and misoprostol-only purchasers (November 2014-August 2016, N=169,619).

Characteristic of call or caller	Combination regimen (n=95,447), n (%)	Misoprostol only (n=74,210), n (%)	P value
Type of caller			.001
Pharmaceutical representative	523 (0.55)	481 (0.65)	
Pharmacist or Pharmacy worker	21,993 (23.05)	18,207 (24.54)	
Village doctor	17,920 (18.78)	13,740 (18.52)	
Menstrual regulation (MR) user (woman)	25,648 (26.88)	16,315 (21.99)	
Husband of MR user	17,156 (17.98)	15,741 (21.22)	
Mother and other relative of MR user	6919 (7.25)	5411 (7.29)	
Friend of MR user	5163 (5.41)	4236 (5.71)	
Don't know, refuse and missing	103 (0.11)	63 (0.08)	
Reported age of MR user (years)			.001
<20	25,625 (26.85)	18,232 (24.57)	
20-24	32,454 (34.00)	26,973 (36.35)	
25-29	20,127 (21.09)	15,799 (21.29)	
30 or older	13,748 (14.40)	10,593 (14.27)	
Don't know, refuse and missing	3493 (3.66)	2613 (3.52)	
Repeat caller^a	42,855 (44.90)	32,821 (44.23)	.001
MR user had taken drug before calling			.001
Taken complete regimen	18,099 (18.96)	12,106 (16.31)	
Started the regimen	5097 (5.34)	6947 (9.36)	
Not taken	70,224 (73.57)	52,519 (70.77)	
Don't know and other	2027 (2.12)	2638 (3.55)	
Specific MR-related query^b			
Whether misoprostol or combination pack used for MR	93,468 (97.93)	70,677 (95.24)	.001
Correct MR dosage and regimen	70,224 (73.57)	52,523 (70.78)	.001
Information on side effects or complications	70,224 (73.57)	52,523 (70.78)	.001
Experiencing side effects	18,750(19.64)	13,422 (18.09)	.001
Caller suspects complications	2942 (3.08)	2783 (3.75)	.001
Thinks they have taken the wrong dose ^c	2024 (2.12)	2650 (3.57)	.001
Questions about pain medication	6854 (7.18)	6431 (8.67)	.001
Accessing clinic or hospital	4739 (4.97)	5245 (7.07)	.001
Type of side effect reported^d			
Nausea	757 (0.79)	508 (0.68)	.01
Vomiting	1489 (1.56)	1308 (1.76)	.001
Diarrhea	4136 (4.33)	3376 (4.55)	.03
Headache	1937 (2.03)	589 (0.79)	.001
Cramps	6850 (7.18)	6379 (8.60)	.001
Bleeding	5981 (6.27)	2041 (2.75)	.001
Fever	2009 (2.10)	2377 (3.20)	.001

^aQuestion introduced in July 2013.^bMultiple responses are allowed, so percentage may sum to more than 100%.^cNo data available in September 2013-October 2014.

^dQuestion introduced in July 2013.

Discussion

Principal Findings

This study analyzed the usage patterns of a call center in Bangladesh that was established to reduce harm from potential incorrect use of MR medications, and the findings point to the effectiveness and feasibility of this approach. Consistent with findings from surveys of pharmacy workers undertaken in 2011 [19] and in 2013 [21], the results suggest that misoprostol and, more recently, the combination regimen are being used widely for MR but that gaps in knowledge exist among both end users and drug providers. There was a high and increasing number of calls about MR over the 4-year period, suggesting that the call center addressed an unmet need for information. MR users and their relatives, and providers or sellers of medications most often called for information about the correct dosage, and the potential side effects or complications of MR medications. Changes in the types of drugs available for MR were associated with changes in call center use. The high call volume and high proportion of repeat calls suggests that the call center method of communicating information on this stigmatized issue is acceptable to both providers and end users and their relatives, including younger women, and that mHealth initiatives can successfully reach women, providers, and their relatives of different ages and geographical areas of Bangladesh [29].

This study adds to the evidence on call center support for maternal and reproductive health issues [12,29,30] by detailing the experience in Bangladesh, where availability of information on MR medications remains insufficient.

Improving the quality of information available to women who purchase mifepristone or misoprostol from pharmacies is a challenge, and although pharmacy worker-focused interventions such as training and detailing have had some impact on pharmacy provision [3,31,32], these interventions can be expensive and difficult to provide at scale. In addition, they may not be appropriate in contexts where staff turnover at pharmacies is high [2]. Our analysis suggests that in addition to making information available to the end user directly, a call center intervention can make information available to those selling MR medications or advising local communities on health issues. The potential to reduce harm from incorrect use of MR medications is reflected in the fact that the majority of callers made contact before taking the products. That nearly one-fifth of calls were from village doctors deserves further investigation on the role of these health providers on providing MR and reproductive health care. Although a lot of current research concentrates on pharmacies as frontline providers, village doctors may be another way of improving access to quality care in hard-to-reach populations.

An important function of the call center is to provide referral information to women experiencing complications after taking misoprostol for MR. The WHO recommended a misoprostol-only MR regimen of 800 mcg taken sublingually up to 3 times at 6-, 12-, and 24-hour intervals [33] has been found to have an 85% to 90% effectiveness rate [34,35]. If

callers to the MSB call center were representative of misoprostol-only MR users, we would therefore expect a minimum of 15% of women to have experienced an incomplete MR. Of misoprostol-only callers to the call center, 2.7% reported that the end user was experiencing suspected complications, all of which were suspected incomplete procedures. This suggests that most women who are experiencing complications or incomplete MR are not calling the call center for support. It is possible that these women may be going directly to clinics or back to the drug seller to receive follow-up care, but further research into the care-seeking patterns of women who experience incomplete MR after using misoprostol alone is required.

Unsurprisingly, the introduction of the combination pack into the market was followed by a decline in the number of calls regarding misoprostol-only MR and an increase in calls about the combination regimen. As increases in calls were clearly linked to when various brands started to include the call center number on the packaging, it also suggests the efficacy of this technique to publicize call centers as a source of support for women self-administering MR medications. Unlike misoprostol, the combination regimen is packaged for MR with instructions on use. ITS analysis showed that after the call center number started to be printed on combination regimen packaging, significantly more calls were made about MR users who had taken the complete regimen and who were experiencing side effects and wanted information on pain medication. Conversely, downward trends were seen after November 2014 for enquires about dosage, regimen, and asking for information on side effects, which is logical given that the combination regimen pack prints usage instructions. This suggests that after the introduction of the combination regimen to the market, callers more often called later in the MR process and with different kinds of queries.

Our sample is likely not representative of all women who are accessing MR medications through pharmacies in Bangladesh, and preliminary analyses suggest that call center users may be younger than the general population of MR users in Bangladesh. As a crude comparison of age distribution, we used the 2014 Bangladesh Demographic and Health survey (DHS) [9] to calculate the age distribution of women who reported having used MR in the previous 3 years (N=538) and compared this with the reported age distribution of MR users reported to call center operators. The age profile of recent MR users from the DHS is notably older, with the majority (87.7%) being 25 years and older; and the majority of users reporting being between 30 and 34 years. Although the differing age distributions could be partly related to the DHS reference period of 3 years or underreporting of MR by younger women in the DHS, it could also suggest that MR users contacting the call center may be on average younger than the general population of MR users. This may reflect younger women being more likely to access MR using medications, to access it through pharmacies, to have a query about it, and to use the call center. Younger women may also face additional barriers to accessing MR facility services due to age, childbearing, and partnership norms [36].

Limitations

Our study has some limitations and implications for further research. We collected limited data on repeat callers, and these were not linked, so the characteristics of the 45% of calls who are repeat callers are overrepresented in the data. It would be useful to understand more about repeat callers: why they called more than once and the duration between calls, for example. Further information is also needed about non-MR callers, as the numbers of these have been increasing and now account for a quarter of calls. This could suggest a further need for accessible advice for other reproductive health issues such as family planning or a change in the way the call center is promoted to better address other reproductive health needs. Further research is needed to understand the impact of this intervention on provider provision practices and client outcomes

such as complete MR, use of post-MR family planning, and access to appropriate treatment for complications.

Conclusions

Evidence has demonstrated that availability of misoprostol can lead to a decrease in the rate and severity of abortion complications [4]. To achieve this, a comprehensive harm reduction approach is needed; the key components include procuring and distributing high-quality drugs, ensuring training and support mechanisms for providers, building effective referral mechanisms for complication management, and addressing the need for postabortion family planning. This study demonstrates that a call center can form an important part of such a harm reduction package by providing information to providers and MR users and advising on post-MR family planning.

Acknowledgments

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Conflicts of Interest

All authors are employed by Marie Stopes International or Marie Stopes Bangladesh, and the call center at the focus of this study is run by these organizations.

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Abbreviations

DHS: Demographic and Health survey

ITS: interrupted time series

LMIC: low- and middle-income country

mHealth: mobile health

MR: menstrual regulation

MSB: Marie Stopes Bangladesh

MVA: manual vacuum aspiration

WHO: World Health Organization

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