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Article

Sources of information on diabetes and its demographic correlates: a nationwide survey among Singapore residents

Mythily Subramaniam[1,2,*,†], Jue Hua Lau[1,†], P.V. Asharani[1], Edimansyah Abdin[1], Kumarasan Roystonn[1], Peizhi Wang[1], Fiona Devi[1], Janhavi Ajit Vaingankar[1], Lorainne Tudor Car[3], Chee Fang Sum[4], Eng Sing Lee[5], Rob M. van Dam[2,6], and Siow Ann Chong[1]

[1]Research Division, Institute of Mental Health, 10 Buangkok View, Singapore 539747, Singapore
[2]Saw Swee Hock School of Public Health, National University Hospital, Singapore
[3]Lee Kong Chian School of Medicine, Nanyang Technological University, 50 Nanyang Avenue, Singapore
[4]Admiralty Medical Centre, Khoo Teck Puat Hospital, 676 Woodlands Drive 71, Singapore
[5]National Healthcare Group Polyclinics, 3 Fusionopolis Link, Nexus@One-North, Singapore
[6]Department of Exercise and Nutrition Sciences, Milken Institute of Public Health, The George Washington University, Washington, DC, USA

[*]Corresponding author. E-mail: Mythily@imh.com.sg
[†]Joint first authors.

Summary

Diabetes is a major public health concern in Singapore, and the Singapore Government declared a 'War on Diabetes', which included a nationwide public health campaign. It is important to identify what sources of diabetes information reach the general population, whether this differs by socio-demographic characteristics and if the sources of information influence knowledge of diabetes to aid the successful dissemination of health information. Two thousand eight hundred ninety-five respondents were part of a population-based cross-sectional study conducted from February 2019 to September 2020. Respondents rated on a five-point scale whether they had obtained information on diabetes from eight different information sources, and responses were dichotomized into 'endorsed receiving information' or 'not endorsed receiving information'. Poisson regression models were conducted with the 'endorsement of receiving information' from each source as the outcome and socio-demographic variables as predictors. 95.9% of the study population had received information on diabetes from at least one source, and the mean number of sources was 4.2 ± 2.0. The leading source was media articles (82.1%), followed by health promotion videos/advertisements (77.9%), online websites (58.5%), books (56.5%), healthcare professionals (55.0%), radio (54.4%), public forums (27.7%) and support groups (15.5%). Endorsing a greater number of informational sources was associated with being younger, belonging to Malay or Indian instead of Chinese ethnicity, and having diabetes. An intensive nationwide diabetes awareness campaign successfully reached the public in Singapore with specific sources of information depending on socio-demographic characteristics. Findings suggest that diabetes information campaigns should utilize multiple channels for dissemination considering the different socio-demographic subgroups.

Keywords: sources of information, diabetes, Singapore

INTRODUCTION

The increasing prevalence of diabetes mellitus (DM) has been recognized as a global threat to public health. This rise in prevalence may be driven by a sedentary lifestyle, obesity and increased consumption of red and processed meat, refined grains and sugar-sweetened beverages (Zheng *et al.*, 2018). The International Diabetes Federation (International Diabetes Federation, 2019) estimated that 463 million

adults worldwide (a prevalence of 8.3%) had diabetes in 2019. Furthermore, about 6.7 million deaths worldwide occur due to diabetes every year, of which 1.3 million are in the Western Pacific Region (which includes 39 countries such as China, Thailand, Malaysia and Singapore). Researchers have posited that Asian populations have disproportionately higher percentages of diabetes compared with European populations as they have more risk factors for developing Type 2 diabetes (Chan *et al*., 2009). For example, Chan *et al*. suggested that those of Asian ancestry were more likely to have less muscle and more abdominal fat, associated with increased insulin resistance (Chan *et al*., 2009). Furthermore, there has been some evidence that white rice and refined grains that contribute to a large and unbalanced proportion of daily energy intake in Asian diets are linked to diabetes (van Dam, 2020). Furthermore, the rise in consumption of western-style fast food in Asian populations such as Singapore has also been linked to the increased risk (Odegaard *et al*., 2012; Pan *et al*., 2012).

Awareness campaigns may help mitigate the rising prevalence and management of diabetes in the general population. Diabetes has been suggested to be a 'silent killer', and many who suffer from the condition are only aware that they have it when they develop a serious complication (Campbell, 2001; Wee *et al*., 2002). Therefore, raising awareness of the symptoms, causes and complications of diabetes and its link with obesity, poor diet, lack of physical activity and a sedentary lifestyle would be critical for the early diagnosis, prevention and management of diabetes (Matthaei *et al*., 2007). Awareness and knowledge of diabetes have been associated with health-promoting self-care behaviours that can prevent diabetes in high-risk populations like individuals with pre-diabetes (Chen *et al*., 2015). It can also result in good outcomes (adequate glycaemic control, reduction of complications, etc.) in people with diabetes (Shrivastava *et al*., 2013). Research has suggested that public health mass media campaigns are an important source of health information for individuals (Randolph and Viswanath, 2004). Public health mass media campaigns have been defined as 'public health interventions that use organized communication activities to inform, persuade or motivate behaviour change in a relatively large number of individuals, usually within a specific period' (Stead *et al*., 2019; Torloni *et al*., 2020). Mass media campaigns use both traditional media channels, such as radio, newspapers and magazines and digital media channels, including websites, QR codes, viral marketing and social media, to produce positive changes and prevent negative changes in health-related behaviours across the population (Wakefield *et al*., 2010). For example, a mass media campaign in the USA aimed to increase awareness of added sugars in sugary drinks and the adverse health impacts of these beverages. The campaign resulted in increased awareness, with people acquiring knowledge about health problems associated with excessive sugar consumption and stating their intention to reduce the consumption of these beverages in children (Boles *et al*., 2014). Similarly, a mass media campaign in Brazil successfully increased knowledge in adults aged 40 and over about the importance of diabetes and increased participation in health screenings (Nucci *et al*., 2004). Thus, leveraging mass media to promote diabetes-related health information and prevention may facilitate behavioural change in populations.

Within the metropolitan nation-state of Singapore, estimates of the crude prevalence of diabetes showed an increasing trend over the years, from 8.6% in 2010 to 9.5% in 2020 (Ministry of Health, Singapore, 2020). In 2016, the Singapore Ministry of Health declared a 'War on Diabetes' to stem the rising prevalence of DM. To better grasp public sentiment, the Health Promotion Board (HPB) of Singapore organized engagement sessions with the public in 2016. About 2000 responses were gathered, which provided a better understanding of the attitudes towards diabetes and barriers to healthy living. The consultation was followed by co-creating programs with the community to 'fight' Type 2 diabetes. A citizen's jury was convened in late 2017, wherein participants from the community worked with subject matter experts to develop recommendations, which HPB and other organizations progressively implemented from 2018. Finally, a sustained public media campaign led the thrust through press releases, YouTube videos and newspaper articles (Ministry of Health, 2021; Ow Yong and Koe, 2021). Although this was the first campaign specifically addressing diabetes, earlier campaigns, such as the National Healthy Lifestyle campaign introduced in 1992, were mounted to raise awareness of the benefits of healthy diets and physical activity (Health Promotion Board, 2015). While the information on diabetes is provided by multiple sources in Singapore, including healthcare providers, news coverage and social media, there is a dearth of published data regarding how the Singapore population obtains health information specific to diabetes. Little too is known about the influence of information sources on diabetes knowledge in the general population. The unique government-led 'War on Diabetes' initiative in Singapore provides an opportunity to assess the impact of an intense nationwide diabetes awareness campaign on the general population.

Therefore, the aims of the present study were to (i) identify the leading sources of diabetes-related information in the general population, (ii) examine socio-demographic factors associated with receiving a higher number of sources of diabetes information, (iii)

examine socio-demographic factors associated with receiving eight specific sources of diabetes information (i.e. healthcare professionals, books, media articles, online websites, public forums, support groups, health promotion videos/advertisements and radio) and (iv) to ascertain if a relationship exists between information sources and the level of diabetes knowledge.

METHODS

Sample and procedure

The present study is part of a population-based, cross-sectional study evaluating the Knowledge, Practice, and Attitudes (KAP) (AshaRani *et al*., 2020) towards diabetes amongst residents of Singapore aged 18 and above. The study's sample size was determined using 20% as a prevalence estimate of diabetes knowledge in Singapore based on an earlier study (Wee *et al*., 2002). A total sample size of 3000 was estimated to be adequate to determine the general knowledge of diabetes in the population. Further details of the sampling strategy and processes are published in an earlier article (AshaRani *et al*., 2020).

The sample was randomly selected via a disproportionate stratified sampling design according to the ethnicity (Chinese, Malay, Indian, Others) and age groups (18–34, 35–49, 50–64, 65 years and above) from a national population registry database of all citizens and permanent residents within Singapore. In addition, the study oversampled specific minority populations, such as those of Malay and Indian ethnicity and those above 65 years of age, to improve the reliability of the parameter estimates for these groups.

The selected residents were sent notification letters followed by home visits by a trained interviewer from a survey research company to obtain their informed consent to participate in the study. Face-to-face interviews with residents who agreed to participate were conducted in their preferred language (English, Mandarin, Bahasa Melayu or Tamil). Responses were captured using computer-assisted personal interviewing. Individuals who were unable to be contacted due to incomplete or incorrect addresses or were living outside of the country, those who were incapable of doing the interview due to severe physical or mental conditions, language barriers, or were institutionalized or hospitalized at the time of the survey were excluded from the study. The study commenced in February 2019 but was suspended during the lockdown period (March 2020–July 2020) in Singapore in response to the Coronavirus pandemic. It was resumed in August 2020 while adhering to safe distancing and masking measures, and recruitment was closed in September 2020. Written informed consent was obtained from all respondents before the survey, and all study procedures were conducted in accordance with ethical guidelines (Domain Specific Review Board ref: 2018/00430).

Measures

Sources of diabetes information

Participants were asked, '*How have you received/ gathered information on diabetes?*' This was followed by the presentation of eight different sources of information. The question is similar to that used in earlier studies (Strauss *et al*., 2013; Cántaro *et al*., 2016). The sources of information were based on the scientific literature examining diabetes-related information-seeking behaviour (Kuske *et al*., 2017) and the dissemination strategies of health information in Singapore. The sources of diabetes-related information that we asked about included: (i) healthcare professionals (doctors, nurses, dietitians), (ii) books, (iii) media articles (did not specify print or online), (iv) online websites, (v) public forums (diabetes-related talks by healthcare professionals which usually includes a question and answer session), (vi) support groups (community-based or online groups where people with diabetes can share information, give and receive support), (vii) health promotion videos/advertisements (e.g. television/cinema/YouTube advertisements) and (viii) radio (discussions/advertisements). Responses were measured on a five-point scale of 1 ('Strongly Agree') to 5 ('Strongly Disagree'). For the present analysis, these responses were dichotomized into two categories: (i) Endorsed receiving information (strongly agree and agree) and (ii) Did not endorse receiving information (strongly disagree, disagree and neither agree nor disagree).

Diabetes knowledge

Diabetes knowledge was tested based on 12 questions (Supplementary Table 1). Scores were created by summing the correct responses of the individual items. Scores ranged from 0 to 12, with higher scores indicating higher knowledge. In accordance with previous research, good knowledge was defined as more than 75% correct answers (9 or more) (Cántaro *et al*., 2016).

The respondents' socio-demographic information such as age, gender, ethnicity, education, employment status and monthly personal income were also collected. Information regarding physician diagnosis of diabetes (Types 1 and 2) was obtained via self-report.

Statistical analysis

All data analyses were conducted with Stata version 15 (StataCorp LLC, USA). Frequency and survey-weighted percentages are provided for categorical variables. Descriptive information regarding the endorsement of receiving information from each of the eight sources of information is tabulated. Poisson regression analysis

was used to examine the association between socio-demographic variables and the number of sources endorsed. Poisson regression was considered suitable as the number of sources endorsed is a count variable. The mean number of sources endorsed (mean = 4.21) was similar to the variance (variance = 4.00), indicating no overdispersion. The Poisson regression coefficients were exponentiated and referred to as rate ratio to indicate the ratio of the rate of counts between two levels of a binary predictor, the ratio between the level of interest and the reference level for a categorical predictor and the ratio of the higher value to the value at the next lowest level of a continuous predictor variable (Hilbe, 2014).

Multivariable Poisson regression analysis with robust standard errors (Zou, 2004; Chen *et al.*, 2018) was also conducted to examine the magnitude association between socio-demographic variables and each of the eight sources of information (endorsement vs. no endorsement). Subsequently, we examined the association between sources of information and a good level of knowledge regarding diabetes as a binary outcome. The magnitude of association was assessed using adjusted prevalence ratios (APR) with their 95% confidence interval (CI) after adjusting for all socio-demographic determinants (Cántaro *et al.*, 2016). The socio-demographic determinants included in each model were age, gender, ethnicity, education, employment, monthly personal income and having a history of diabetes. All regression analyses used survey weights to account for the complex survey design.

RESULTS

Socio-demographic characteristics of the sample

Two thousand eight hundred ninety-five respondents were recruited from the general population (5698 were screened; the response rate was 66.2% and the eligibility rate was 76.8%). The socio-demographic characteristics of the study population are presented in Supplementary Table 2. Each age group was well represented, and there were an approximately equal number of males and females. 29.5% of the population had a university degree and above education level. 70.5% were employed, and 45.3% reported having income below 2000 SGD or no income. In addition, 9.1% had diabetes.

Sources of information on diabetes

95.9% of the study population endorsed receiving information on diabetes from at least one source, while the remaining 4.1% did not endorse any information sources. The leading source of information on diabetes was media articles at 82.1%, followed in descending order by health promotion videos/advertisements (77.9%), online websites (58.5%), books (56.5%), healthcare professionals (55.0%), radio (54.4%), public forums (27.7%) and support groups (15.5%).

Among those with diabetes, only 0.05% did not endorse receiving information from any of the sources of information. The top source of information on diabetes among this group was healthcare professionals (94.7%), followed by health promotion videos (81.1%), media articles (78.6%), radio (65.0%), books (63.4%), online websites (43.7%), public forums (35.6%) and support groups (25.4%) (Table 1).

Socio-demographic correlates associated with endorsement of information sources

Age, ethnicity and having a history of diabetes were significantly associated with the number of sources endorsed (Supplementary Table 3). Compared with those aged 65 years and above, individuals aged 50–64 and 35–49 years were 12% and 14% more likely to endorse information sources. Individuals of Malay and Indian ethnicity endorsed more (14% and 9%, respectively) information sources than those of Chinese ethnicity. Those with diabetes had a 13% higher endorsement of sources than those without diabetes.

Results of the multivariable Poisson regression models examining socio-demographic determinants of the top four sources of information on diabetes (i.e. media articles, health promotion videos/advertisements, online websites and books) within the study population are presented in Table 2. The remaining four sources (i.e. healthcare professionals, radio, public forum and support groups) are shown in Table 3.

Age was significantly associated with the endorsement of receiving information from several sources. Compared with those aged 65 years and above, the proportion of receiving information from online websites was 1.6 [95% CI (1.24, 2.05)], 1.87 [95% CI (1.45, 2.42)] and 1.86 [95% CI (1.45, 2.4)] times higher among those aged 50–64, 35–49 and 18–34 years, respectively. However, for those aged 18–34 years the proportion of receiving information from books [APR of 18–34 vs. 65 years and above = 0.83, 95% CI (0.69–0.99)], radio [APR of 18–34 vs. 65 years and above = 0.67, 95% CI (0.55–0.82)] and public forums [APR of 18–34 vs. 65 years and above = 0.55, 95% CI (0.39–0.79)] was significantly less as compared with those aged 65 years and above.

Gender was significantly associated with receiving information from books. The proportion of receiving information on diabetes from books was 0.12 points lower in males than in females [APR of males vs. females: 0.88, 95% CI (0.8, 0.97)].

Differences between ethnic groups were observed in endorsing all sources of information apart from public

Table 1: Endorsement of eight different sources of diabetes information in the study population and participants with diabetes

	Total sample (n = 2895)						Only those with diabetes (n = 436)					
	Did not endorse receiving information (Strongly Disagree/ Disagree/ Neither)		Endorsed receiving information (Strongly Agree/Agree)		Don't know/ refused a		Did not endorse receiving information (Strongly Disagree/ Disagree/ Neither)		Endorsed receiving information (Strongly Agree/ Agree)		Don't know/ refused a	
	n	W%	*n*	W%	*n*	W%	*n*	W%	*n*	W%	*n*	W%
At least one source[b]	96	4.1	2799	95.9	—	—	1	0.05	435	99.9	—	—
Media articles	600	17.8	2289	82.1	6	0.2	120	21.1	314	78.6	2	0.31
Health promotion videos/ advertisements (e.g. TV, cinema, YouTube advertisements)[c]	517	21.6	2226	77.9	8	0.5	81	18.9	342	81.1	6	2.41
Online websites	1170	40.6	1645	58.5	80	0.8	206	53.0	190	43.7	40	3.38
Books	1194	43.5	1695	56.5	6	0.1	153	36.4	282	63.4	1	0.15
Healthcare professionals (Doctors, Nurses, Dieticians)	1030	44.9	1862	55.0	3	0.1	16	4.3	418	94.7	2	1.08
Radio (discussions, advertisements etc.)[c]	1137	45.4	1607	54.4	7	0.3	135	35.1	288	65.0	0	0
Public forums	2025	71.5	839	27.7	31	0.8	274	62.8	154	35.6	8	1.61
Support groups	2276	83.1	584	15.5	35	1.4	303	72.2	127	25.4	6	2.41

Percentages across rows may not add up to 100% due to rounding of decimal values.
[a]Don't know, and missing information for each of the eight information sources were removed from subsequent logistic regression analyses.
[b]Endorsement of at least one source of information included individuals who indicated refused/don't know or had missing data (i.e. they would be counted if they had endorsed at least one source of information regardless of whether or not there was missing data in their other responses).
[c]n = 2751; 144 cases had missing information on the two indicated items as they were added later in the study as an amendment. For the diabetes sample, n = 423, with 3 cases of missing information.
W% = Weighted %.

Table 2: The association between socio-demographic characteristics and receiving specific sources of information about diabetes for the top four sources

	Media articlesa				Health promotion videos/ advertisementsb				Online websitesc				Booksd			
	APR	95%	CI	*p**	APR	95%	CI	*p**	PR	95%	CI	*p**	APR	95%	CI	*p**
Age group (in years)																
65 and above	ref				ref				ref				ref			
50–64	1.06	0.97	1.17	0.21	1.05	0.94	1.17	0.39	1.6	1.24	2.05	**<0.001**	1.11	0.95	1.29	0.2
35–49	1.03	0.93	1.14	0.59	1.11	0.98	1.26	0.09	1.87	1.45	2.42	**<0.001**	0.96	0.81	1.16	0.7
18–34	0.95	0.86	1.06	0.35	1.07	0.95	1.21	0.26	1.86	1.45	2.4	**<0.001**	0.83	0.69	0.99	**0.04**
Gender																
Female	ref				ref				ref				ref			
Male	0.98	0.93	1.03	0.46	0.95	0.89	1.01	0.1	1.02	0.94	1.11	0.65	0.88	0.8	0.97	**0.01**
Ethnicity																
Chinese	ref				ref				ref				ref			
Malay	1.01	0.96	1.07	0.64	1.1	1.05	1.16	**<0.001**	1.1	1.01	1.2	**0.03**	1.09	0.99	1.2	0.07
Indian	0.94	0.89	0.98	**0.01**	1.06	1.005	1.12	**0.03**	1.02	0.95	1.1	0.6	1.13	1.04	1.23	**0.01**
Others	0.99	0.92	1.06	0.7	0.94	0.84	1.05	0.3	1.05	0.94	1.17	0.38	1.16	1.01	1.34	**0.03**
Education																
Degree, professional certification and above	ref				ref				ref				ref			
Primary and below	0.78	0.7	0.87	**<0.001**	0.98	0.87	1.11	0.76	0.47	0.37	0.6	**<0.001**	0.94	0.78	1.13	0.5
Secondary school	0.95	0.87	1.02	0.17	0.98	0.88	1.09	0.69	0.84	0.73	0.97	**0.02**	0.98	0.83	1.16	0.8
Pre-University/junior college**	0.98	0.88	1.1	0.77	0.9	0.75	1.08	0.26	1.02	0.85	1.22	0.83	1.28	1.04	1.56	**0.02**
Vocational institute/ITE	0.9	0.8	1.02	0.09	0.96	0.84	1.09	0.51	0.81	0.68	0.97	**0.02**	0.83	0.65	1.06	0.13
Diploma	0.95	0.88	1.02	0.17	0.94	0.85	1.04	0.22	0.99	0.88	1.1	0.82	0.96	0.82	1.13	0.64
Employment																
Employed	ref				ref				ref				ref			
Economically inactive	1.00	0.92	1.08	0.92	1.00	0.92	1.1	0.94	1.05	0.91	1.21	0.48	1.02	0.89	1.16	0.77
Unemployed	0.97	0.85	1.12	0.71	1.13	1.02	1.24	**0.01**	0.98	0.77	1.25	0.9	0.95	0.74	1.22	0.69
Monthly personal income (in SGD)																
Below 2000 and no income	ref				ref				ref				ref			
2000–3999	0.98	0.9	1.06	0.59	1.02	0.94	1.12	0.59	1.00	0.87	1.15	0.99	1.00	0.87	1.15	0.96
4000–5999	1.02	0.94	1.11	0.65	0.96	0.85	1.08	0.49	1.08	0.93	1.26	0.3	1.11	0.93	1.33	0.23
6000–9999	1.01	0.91	1.12	0.82	0.9	0.77	1.05	0.18	0.93	0.76	1.13	0.44	0.89	0.69	1.13	0.33
10 000 and above	1.02	0.92	1.13	0.67	0.86	0.71	1.05	0.14	1.02	0.83	1.25	0.86	0.97	0.75	1.26	0.83

Table 2. Continued

	Media articlesa				Health promotion videos/ advertisementsb				Online websitesc				Booksd			
	APR	95% CI		*p**	APR	95% CI		*p**	PR	95% CI		*p**	APR	95% CI		*p**
Diabetes																
No diabetes	ref				ref				ref				ref			
Has diabetes	0.99	0.9	1.08	0.81	1.04	0.95	1.14	0.42	0.99	0.82	1.2	0.92	1.04	0.9	1.2	0.6

Numbers may not tally with the total sample size due to missing data (e.g, those who refused to provide information regarding income, BMI). Bold print highlights statistically significant adjusted prevalence ratio. Economically inactive: students, housewives and retirees. ITE: Institute of Technical Education.
After listwise deletion of missing data (survey-weighted percentages displayed in parenthesis):
[a]*n* = 2765; no endorsement (ref) *n* = 585 (18.18%); endorsed *n* = 2061 (81.82%).
[b]*n* = 2620; no endorsement (ref) *n* = 493 (21.92%); endorsed *n* = 2127 (78.08%).
[c]*n* = 2691; no endorsement (ref) *n* = 1105 (40.66%); endorsed *n* = 1586 (59.34%).
[d]*n* = *n* = 2766; no endorsement (ref) *n* = 1141 (43.05%); endorsed *n* = 1625 (56.95%).
*Multivariable Poisson regression adjusted for age, gender, ethnicity, education, employment, monthly personal income and having a history of diabetes.
**Equivalent to completion of 12th grade in the US school system.

forums. For example, participants of Malay ethnicity had a higher proportion of receiving information from several sources of information as compared with those of Chinese ethnicity—1.1 times higher from health promotion videos/advertisements [95% CI (1.05, 1.6)]; 1.1 times higher from online websites [95% CI (1.01, 1.2)]; 1.33 times higher from healthcare professionals [95% CI (1.22, 1.45)]; 1.21 times higher from radio [95% CI (1.1, 1.33)] and 1.59 times higher from support groups [95% CI (1.26, 2.01)]. Similarly, those of Indian ethnicity had a higher proportion of receiving information from several sources of information as compared with those of Chinese ethnicity—1.06 times higher from health promotion videos/ advertisements [95% CI (1.005, 1.12)]; 1.13 times higher from books [95% CI (1.04, 1.23)]; 1.29 times higher from healthcare professionals [95% CI (1.18, 1.4)]; 1.12 times higher from radio [95% CI (1.02, 1.24)] and 1.52 times higher from support groups [95% CI (1.21, 1.91)]. However, they had a 0.94 times lower proportion of receiving information from media articles than those of Chinese ethnicity [95% CI (0.89, 0.98)]. The proportion of those of other ethnicities receiving information from books [APR of other ethnicities vs. Chinese: 1.16; 95% CI (1.01, 1.34)] and healthcare professionals [APR of other ethnicities vs. Chinese: 1.25, 95% CI (1.08, 1.45)], was higher than those of Chinese ethnicity. However, compared with those of Chinese ethnicity the proportion of those with other ethnicities receiving information from the radio was lower [APR of other ethnicities vs. Chinese: 0.75, 95% CI (0.6, 0.93)].

Compared with those with a degree and higher education, the proportion of those with primary school education receiving information from media articles were 0.78 times lower [95% CI (0.7, 0.87)] and the proportion of receiving information from online websites was 0.47 times lower [95% CI (0.37, 0.6)]. Compared with those with a degree and higher education, the proportion of those with secondary school and vocational training receiving information from online websites were 0.84 times and 0.81 times lower, respectively [APR of secondary school vs. degree and above: 0.84, 95% CI (0.73, 0.97); APR of vocational institute/ITE vs. degree and above: 0.81, 95% CI (0.68, 0.97)]. The proportion of those with pre-university and junior college (equivalent to high school) education receiving information from books were 1.28 [95% CI (1.04, 1.56)] times higher than those with degrees and above education.

The proportion of those who were unemployed receiving information from health promotion videos/ advertisements were 1.13 times higher [95% CI (1.02, 1.24)] than among those who were employed. Income was not significantly associated with receiving any sources of information on diabetes. Individuals who

Table 3: Associations between socio-demographic characteristics and receiving specific sources of diabetes information for the bottom four sources of information

	Healthcare professionalsa				Radiob				Public forumsc				Support groupsd			
	APR	95%	CI	*p**	APR	95%	CI	*p**	APR	95%	CI	*p**	APR	95%	CI	*p**
Age group (in years)																
65 and above	ref				ref				ref				ref			
50–64	1.11	0.97	1.28	0.14	1.08	0.93	1.25	0.33	1.2	0.92	1.58	0.18	1.00	0.69	1.45	0.98
35–49	1.07	0.9	1.28	0.46	1.09	0.91	1.31	0.33	1.22	0.89	1.67	0.22	1.14	0.75	1.74	0.54
18–34	0.85	0.71	1.03	0.11	0.67	0.55	0.82	**<0.001**	0.55	0.39	0.79	**<0.001**	0.76	0.48	1.22	0.26
Gender																
Female	ref				ref				ref				ref			
Male	1.07	0.97	1.18	0.17	0.93	0.84	1.03	0.18	1.04	0.87	1.24	0.67	0.99	0.77	1.28	0.96
Ethnicity																
Chinese	ref				ref				ref				ref			
Malay	1.33	1.22	1.45	**<0.001**	1.21	1.1	1.33	**<0.001**	1.14	0.97	1.34	0.12	1.59	1.26	2.01	**<0.001**
Indian	1.29	1.18	1.4	**<0.001**	1.12	1.02	1.24	**0.02**	1.07	0.91	1.26	0.39	1.52	1.21	1.91	**<0.001**
Others	1.25	1.08	1.45	**<0.001**	0.75	0.6	0.93	**0.01**	0.89	0.65	1.22	0.46	1.41	0.94	2.13	0.1
Education																
Degree, professional certification and above	ref				ref				ref				ref			
Primary and below	1.14	0.95	1.37	0.16	1.22	1.00	1.48	**0.04**	1.02	0.71	1.44	0.93	1.58	1.01	2.47	**0.04**
Secondary school	0.98	0.82	1.16	0.78	0.97	0.81	1.18	0.78	1.13	0.83	1.54	0.42	1.37	0.91	2.07	0.14
Pre-University/junior college**	0.87	0.64	1.17	0.36	1.26	0.98	1.61	0.07	1.06	0.67	1.7	0.79	1.18	0.6	2.3	0.63
Vocational institute/ITE	0.83	0.66	1.05	0.12	1.05	0.83	1.32	0.68	1.04	0.71	1.53	0.82	1.44	0.88	2.35	0.15
Diploma	0.92	0.78	1.1	0.36	0.89	0.73	1.08	0.24	1.04	0.77	1.4	0.8	0.9	0.59	1.37	0.62
Employment																
Employed	ref				ref				ref				ref			
Economically inactive	0.97	0.85	1.11	0.66	0.87	0.75	0.99	**0.04**	1.00	0.78	1.28	0.99	1.08	0.76	1.54	0.67
Unemployed	0.97	0.77	1.2	0.75	0.97	0.76	1.22	0.77	0.93	0.59	1.46	0.74	1.48	0.9	2.46	0.13
Monthly personal income (in SGD)																
Below 2000 and no income	ref				ref				ref				ref			
2000–3999	0.99	0.86	1.13	0.85	1.08	0.94	1.24	0.28	1.04	0.8	1.34	0.79	1.21	0.84	1.73	0.31
4000–5999	1.03	0.86	1.23	0.76	1.00	0.82	1.21	0.97	1.04	0.76	1.44	0.8	1.16	0.75	1.81	0.5
6000–9999	0.85	0.66	1.1	0.22	0.85	0.66	1.1	0.22	0.75	0.48	1.15	0.19	0.71	0.39	1.3	0.27
10 000 and above	0.94	0.71	1.24	0.66	0.85	0.62	1.16	0.31	0.88	0.54	1.43	0.61	1.31	0.66	2.61	0.44
Diabetes																

Table 3. Continued

	Healthcare professionals[a]				Radio[b]				Public forums[c]				Support groups[d]			
	APR	95%	CI	p*	APR	95%	CI	p*	APR	95%	CI	p*	APR	95%	CI	p*
No diabetes	ref				ref				ref				ref			
Has diabetes	1.62	1.49	1.75	<0.001	1.05	0.91	1.21	0.48	1.1	0.85	1.41	0.48	1.37	0.99	1.89	0.06

Numbers may not tally with the total sample size due to missing data (e.g. those who refused to provide information regarding income, BMI). Bold print highlights a statistically significant prevalence ratio. ITE: Institute of Technical Education. Economically inactive: students, housewives and retirees.

After listwise deletion of missing data (survey-weighted percentages displayed in parenthesis):

[a]n = 2768; no endorsement (ref) n = 975 (44.42%); endorsed n = 1793 (55.58%).

[b]n = 2620; no endorsement (ref) n = 1085 (45.59%); endorsed n = 1535 (54.41%).

[c]n = 2740; no endorsement (ref) n = 1919 (71.42%); endorsed n = 821 (28.58%).

[d]n = 2737; no endorsement (ref) n = 2159 (83.60%); endorsed n = 518 (16.40%).

*Multivariable Poisson regression adjusted for age, gender, ethnicity, education, employment, monthly personal income and having a history of diabetes.

**Equivalent to completion of 12th grade in the US school system.

had diabetes were 1.62 times more likely to receive information from healthcare professionals than those without diabetes [95% CI (1.49–1.75)].

Results of the multivariable Poisson regression models examining the association between sources of information and level of knowledge regarding diabetes are presented in Table 4. Those receiving source of information about diabetes through media articles, health promotion videos/advertisements, online websites, books, healthcare professionals, and radio were significantly more likely to have a good level of knowledge regarding diabetes. We also found that those endorsing a greater number of informational sources were significantly associated with good level of knowledge regarding diabetes.

DISCUSSION

Our study surveyed how the general Singaporean population obtains information on diabetes from different media sources. An overwhelming majority (95.9%) of the study population endorsed receiving information from at least one source. The present study also provided an in-depth analysis of diabetes-related information received by the population from eight different sources, which can be helpful to policymakers and campaign managers in targeting select population groups. Media articles were the most cited source of information. However, it is important to note that media articles encompass newspaper articles in print or electronic form, and the latter is often shared across social media or via messaging apps. Therefore, the high percentage of media articles reported as a source may have resulted from access via such secondary sources. Support groups were the least cited source because only those with diabetes and their caregivers would be introduced to such groups by healthcare professionals or other patients with diabetes, and this group comprises a small subset of the population.

To the best of our knowledge, only one other study has examined the sources of diabetes-related information in the general population of Singapore. The current survey findings differ from those of an earlier survey done in Singapore more than two decades before (Wee *et al*., 2002). This earlier survey identified friends and relatives as the primary source of information (67.6%), followed by books, magazines and journals (60%). The Internet (8.7%) was the least cited source of information. While the current study did not ask about friends and relatives as sources of information, media articles, health promotion videos and online websites emerged as the primary sources of information, which people have increasingly turned to in the past decade. These differences emphasize the need for regular surveys to track and understand health information-seeking

Table 4: Association between sources of information and level of knowledge regarding diabetes

	Crude model				Adjusted model			
	PR	Lower	Upper	*p*	PR	Lower	Upper	*p*
Media articles	1.24	1.11	1.38	<0.001	1.22	1.10	1.36	<0.001
Health promotion videos/advertisements	1.17	1.06	1.29	<0.001	1.15	1.05	1.26	<0.001
Online websites	1.04	0.97	1.11	0.33	1.07	0.99	1.16	0.08
Books	1.15	1.08	1.24	<0.001	1.08	1.01	1.17	0.03
Healthcare professionals	1.17	1.09	1.26	<0.001	1.11	1.03	1.19	0.01
Radio	1.19	1.11	1.28	<0.001	1.13	1.05	1.22	<0.001
Public forums	1.10	1.03	1.18	0.01	1.04	0.97	1.12	0.24
Support groups	1.02	0.93	1.12	0.65	0.99	0.91	1.08	0.77
Total number of sources endorsed	1.05	1.03	1.07	<0.001	1.04	1.02	1.06	<0.001

The adjusted model was conducted using multivariable Poisson regression adjusted for age, gender, ethnicity, education, employment, monthly personal income and having a history of diabetes.

behaviours of people with chronic diseases and the general population to ensure comprehensive coverage and maximum impact of public health messaging through appropriate communication channels across populations.

In our study, almost everyone with diabetes endorsed receiving information from at least one of the sources of information. This group's top three information sources were healthcare professionals, followed by health promotion videos and media articles. A study by Kalantzi *et al.* (Kalantzi *et al.*, 2015) examined the information-seeking behaviour of diabetes patients and found that the majority of them (94.6%) relied on their physicians as their primary source of information, followed by the ophthalmologist and the broadcast media (i.e. television and radio). A systematic review of 26 studies examining the information-seeking behaviour of people with diabetes identified the Internet and healthcare professionals as the top two sources of information (Kuske *et al.*, 2017). While sources of information vary across studies, healthcare professionals emerge as a significant source of information among those with diabetes, which is not surprising given their frequent contact with their healthcare providers.

Furthermore, diabetes education and dissemination of information in brochures or newsletters by most diabetes care centres in Singapore ensures that diabetes patients receive a significant amount of information from their healthcare providers. Studies have shown that those with diabetes and other chronic diseases such as cancer have ranked healthcare professionals as their preferred source of information (Robertson *et al.*, 2005; Longo *et al.*, 2009). These findings highlight the need for all diabetes care professionals, especially diabetes educators, to support the information needs of patients.

The study also identified—those of Chinese ethnicity as less likely to have received information about diabetes. Ethnic differences in diabetes have been documented in Singapore: the prevalence of Type 2 diabetes and its risk factors are higher among those of Indian and Malay ethnicities than their Chinese counterparts (Hong *et al.*, 2004; Chiang *et al.*, 2011; Phan *et al.*, 2014; Tan *et al.*, 2018). It is thus possible that those of Indian and Malay ethnicity perceive themselves at a higher risk for diabetes and actively search for information relating to it. There is also a higher likelihood of their family members having diabetes which may have led them to understand the condition better. As a result, they might have paid more attention to diabetes-related information disseminated by various Singapore public health agencies.

Our results thus suggest that media outreach has effectively targeted the high-risk groups as middle-aged (35–64 years) adults and those of Malay and Indian ethnicities endorsed a higher number of sources from which they had received diabetes-related information. However, those of Chinese ethnicity may perceive themselves at low risk and hence may have paid less attention to health messages about diabetes. Therefore, public messaging needs to target these groups while disseminating diabetes-related information to ensure the adoption of healthy lifestyle behaviours, early diagnosis and treatment as these groups are also at risk of diabetes, although the risk is lower.

Lastly, the study also identified the reach of different sources of information across socio-demographic groups. Individuals of different ages have different patterns of media use (Goonawardene *et al.*, 2018) and

varying needs for health information (e.g. diabetes-related information may be more salient and relevant to older adults). Therefore, it is unsurprising to observe differences between age groups in the number and types of information sources. It is important to note that those aged 65 years and above endorsed fewer information sources than those aged 50–64 and 35–49 years, perhaps reflecting barriers due to language fluency and information technology knowledge and skills (Goonawardene *et al.*, 2018). This might result in older adults receiving their information from more limited traditional sources. Older adults were the least likely to utilize online websites for health information, limiting their access to videos and articles disseminated online. This may explain why they were less likely to endorse health promotion videos/advertisements than those aged 35–49 years but did not differ from other age groups in media articles. Those belonging to the younger age group were less likely to endorse books, radio and public forums as sources of information. This may reflect their overall information gathering preferences as they might prefer media articles, online websites and health promotion videos/advertisements as sources of information.

It is unclear why those aged 50–64 years were more likely to endorse healthcare professionals as a source of information than those 65 years and above. Communication between healthcare providers and patients is a reciprocal process influenced by patient and provider characteristics (Verlinde *et al.*, 2012). Older adults who are more likely to have poorer health literacy (Asharani *et al.*, 2021) may adopt a more passive role and not actively seek information (Williams *et al.*, 2007). In addition, healthcare professionals too may prefer to engage younger caregivers and may fail to provide health information to older patients to avoid overwhelming them (Williams *et al.*, 2007). It is also possible that there may be language barriers. For example, older adults of Chinese ethnicity tend to speak in dialects, while those belonging to younger age groups often do not speak dialects. Similarly, older adults of Indian ethnicity tend to speak Tamil or other heritage Indian languages, and healthcare professionals may be younger and not as fluent in these languages (Mathew *et al.*, 2000). The need for information in multiple languages and modes has been expressed by caregivers of older adults in Singapore (Vaingankar *et al.*, 2013). Several studies have shown that older adults place an overwhelming trust in healthcare providers (Donohue *et al.*, 2009; Chaudhuri *et al.*, 2013). Thus, access to information among older adults' must be improved, and their ability to use this information should be encouraged through health education and improved communication with healthcare providers.

Regarding public forums, it was expected that those aged 18–34 were less likely to endorse it as an informational source. These groups are not the target audience for public forums for diabetes, which are often targeted towards patients with existing diabetes who tend to be older (Chua and Soh, 2016). Gender was not significantly associated with the number of information sources endorsed, but it was associated with the endorsement of receiving information from books. This is in line with a study on the reading preferences of book readers in Singapore (National Library Board, 2019), which found that women favoured reading books regarding health and fitness more than men.

Educational differences were also observed within the study. Lower educational groups were less likely to endorse online websites but more likely to endorse radio and support groups. This could be because they are less likely to prefer written information as compared with verbal communication. However, extant research (Grabe *et al.*, 2009; Lind and Boomgaarden, 2019) also suggests that individuals with higher education have better memory for print and digital versions of news articles, possibly due to the increased years of academic practice with reading and writing exercises that are useful for newspaper reading and web surfing. Grabe *et al.* (Grabe *et al.*, 2009) also suggested that even though the lower education group had higher interest and rated news articles as higher in terms of information value, they still gained less information from news articles than the higher education group. Therefore, it is plausible that those with lower education in Singapore may have a lower competence in processing news articles, leading to less information gleaned and a lower endorsement of it as a source of diabetes-related information. On the other hand, the lower educated group's preference for radio and support groups suggests that these sources must be exploited to reach out to this population.

Of those information sources identified by the public, media articles, health promotion videos/advertisements, online websites, books, healthcare professionals and radio were associated with a good level of diabetes knowledge. Our findings are slightly different from Cántaro *et al.*, who identified the Internet, radio, newspapers and other patients as sources associated with a good level of knowledge; however, healthcare professionals were not associated with good diabetes knowledge (Cántaro *et al.*, 2016). Another study showed that receiving information about health from healthcare professionals, friends, family, newspapers, magazines and the Internet was positively associated with diabetes knowledge while receiving information from churches and community organizations was negatively associated with diabetes knowledge (Zhao 2014). In Singapore, as part of the War on Diabetes, information

was carefully curated and disseminated using media articles and advertisements/health promotion videos, which is reflected in the higher knowledge among those who received information from these sources. However, public forums and support groups were not associated with higher knowledge scores, and further research is needed to understand how these sources can be improved.

Limitations and strengths of the study

The sample for the present study was representative of the resident population of Singapore. However, it does present some limitations, one of which was that it only collected data on sources of information on diabetes, but not on their quality, the type of information provided, or whether the health information received had any effect on actual behaviour. While we asked participants whether they had received information from 'health promotion videos/advertisements', which included videos embedded in social media sites, we did not specify social media as a specific category. However, given the extensive use of social media, especially among young people, we should have included it as a separate category. Another limitation is that since the questions only asked whether respondents had received information from a particular source, the findings cannot account for whether they had actively sought information on diabetes or had passively received such information. Lastly, respondents might have felt uncomfortable stating that they had not received or sought any diabetes-related information and endorsed a few sources contributing to social desirability bias. Nevertheless, the study is among the first to examine sources of diabetes-related information in the general population and identified groups that are less likely to receive such information in Singapore. Thus, the findings can enhance media outreach for Singapore's current and ongoing health campaigns.

CONCLUSION

The present study examined the endorsement of eight different types of sources of diabetes-related information within the general population of Singapore. The leading source of information was media articles, through which diabetes-related information reached 82.1% of the population. Campaigns aimed at disseminating information on diabetes should consider the various information sources preferred by the population to reach out better and engage the multiple subgroups in the general population. Given its significant outreach in Singapore, the content and frequency of media articles must be carefully monitored to ensure their accuracy and consistency and be further utilized in public health messaging.

Supplementary Material

Supplementary material is available at *Health Promotion International* online.

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Conflict of Interest

The authors do not have any conflict of interest to declare.

Ethical Approval

Ethical approval for the study was obtained from the relevant ethics committee (Domain Specific Review Board, National Healthcare Group, Singapore), and all respondents provided written informed consent before participating in the study.

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