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Brief communication (Original)

Socioeconomic and lifestyle determinants of blood glucose screening in Malaysia

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Background: The increase in prevalence of diabetes is a serious public health issue. It is well-documented that use of blood glucose screening can help to reduce the risk of developing diabetes.
Objectives: To examine the socioeconomic and lifestyle factors associated with use of blood glucose screening among Malaysian adults.
Methods: Nationally representative data from 2,415 survey respondents was used. The survey was a cross-sectional population-based study previously conducted by the Ministry of Health Malaysia. A logistic regression model was developed to estimate the likelihood of using blood glucose screening.
Results: Age, marital status, ethnicity, income, smoking, and body mass index were significantly associated with use of blood glucose screening. In particular, older individuals, married individuals, Malays, higher income earners, non-smokers, and being obese, overweight or of normal weight were correlated with a higher likelihood of using blood glucose screening.
Conclusions: It is important to acquire a better knowledge of the factors that can influence the decision of people to adopt preventive measures. Having better information regarding which groups of individuals use or do not use blood glucose screening can assist governments in developing appropriate intervention programs.

Keywords: Glucose, lifestyle, likelihood, screening, socioeconomic factors

Diabetes is a serious health concern worldwide. Each year, over 300 million people are diagnosed with diabetes [1]. By 2025, it is estimated that Southeast Asian region will have the highest prevalence of diabetes, accounting for 145 million cases [2]. Diabetes is responsible for 3.4 million deaths worldwide, of which the majority (80%) occurred in less-developed and developing countries [3, 4]. The World Health Organization predicted that diabetes would be the leading factor of mortality by 2,030 [5].

A similar trend was noted in Malaysia. The National Health and Morbidity Survey conducted every five years reported that the prevalence of diabetes increased from 6.30% in 1986 to 15.20% in 2011 [2, 6]. This suggests that 2.6 million adults have diabetes, listing Malaysia among the top countries in Southeast Asia with diabetes patients [7, 8]. Diabetes is the leading cause of disability-adjusted life years (DALYs) in Malaysia, with a projected 47,060 DALYs in men and 56,390 DALYs in women [2]. A large percentage (16%) of the Malaysian national health expenditure in 2010 was allocated for diabetes-related treatments, placing Malaysia among the countries in Southeast Asia with the highest proportion spent on diabetes-related treatments resulting in significant economic burden [7].

Diabetes is often asymptomatic and is induced mostly by an unhealthy lifestyle rather than genetic factors [9]. It is widely documented that an early detection of the symptoms can lower the risk of diabetes if followed by proper interventions [9]. Blood glucose screening can help to identify individuals who are at high risk of diabetes when the chances of preventing it are high [9]. Despite this well-known benefit, people seldom make use of blood glucose screening.

Considering the significant role of blood glucose screening in preventing diabetes, it is important to understand the factors associated with use of blood

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glucose screening services. A better knowledge of which groups of individuals use or do not use blood glucose screening can assist governments in formulating an appropriate policy toward reducing the prevalence of diabetes. Although there are nationwide studies examining health screening in Malaysia [10-12], the existing literature is still silent on how socioeconomic and lifestyle factors explain the use of blood glucose screening in particular. While it is notable that Tan [13] investigated diabetes, he focused on the association between a Health Belief Model and various preventive behaviors among ethnic Chinese. The likelihood of using blood glucose screening was also not examined in great detail. The objective of the present study is to fill these research voids.

The present study contributes to the literature in several ways. First, its focus is on a developing country, Malaysia, where diabetes is prevalent and few studies exist. Second, a nationally representative data consisting of a large sample size and detailed information on individual's socioeconomic, lifestyle, and health profiles is used. Third, unlike most other studies that focus solely on socioeconomic factors, the present study considers lifestyle variables in the analysis. Fourth, the findings of the present study facilitate a comparison of the use of health screening between a developing country and the findings for the developed countries.

Materials and methods

Data

The present study used data from the Malaysia Non-Communicable Disease Surveillance-1 survey, which was a nationally representative cross-sectional population-based survey conducted by Ministry of Health Malaysia. The survey covers all the states in Malaysia, and the federal territory of Kuala Lumpur. The survey period was from September 2005 to February 2006. The inclusion criteria were: (1) all individuals aged between 25 and 64 years; (2) both sexes; (3) all races; and (4) Malaysian citizens, while the exclusion criteria were: (1) individuals with serious mental and physical illnesses; (2) pregnant women; and (3) institutionalized individuals. The targeted sample size was calculated based on precision of 1.2%, design effect of 2 and 20% nonrespondents. A sample size of 3,040 was obtained.

The data was collected based on a two-stage stratified sampling. The first stratum comprised of all the states in Malaysia, while the second stratum comprised all the urban and rural areas in each state. The primary stage sampling unit was based on enumeration blocks (EBs), which are artificial geographical areas designed by the Department of Statistics in Malaysia. Each EB comprised 80–120 living quarters (LQs). The secondary stage sampling unit was based on the LQs in each EB. About 3 to 5 LQs were randomly selected from each EB, and all the individuals in the selected LQs were interviewed. Overall, a total of 398 EBs and 1683 LQs were selected.

Trained health professionals used piloted bilingual (*Bahasa Malaysian* and English) questionnaires to interview respondents face-to-face. Written informed consent was obtained from each respondent before their interview. During the interview, the respondents were asked to report their socioeconomic, health, and lifestyle profiles. Meanwhile, physical health of the respondents was examined using standardized methods at the designated health care centers. The study was approved by the Ministry of Heath Malaysia. Further details about the data are published elsewhere [14].

Variables

The outcome variable of the present study, use of blood glucose screening, was formatted as a categorical variable; whether or not the respondents had their blood sugar tested in the past 12 months. Based on past studies that examine the factors associated with use of health screening [10, 12, 15-22], the following socioeconomic and lifestyle factors were selected as explanatory variables: (1) age; (2) gender; (3) marital status; (4) ethnicity; (5) education; (6) income; (7) location of residence; (8) family history of diabetes; (9) smoking; and (10) body mass index (BMI). All these variables were formatted as categorical variables, except age, and the definitions of these variables are quite straightforward as shown in **Table 1**.

Statistical analysis

A logistic regression model was used to examine the odds of respondents using a blood sugar test . Both likelihood ratio (LR) and Hosmer–Lemeshow (HL) tests were conducted to assess the goodness-of-fit of the model. $P < 5\%$ (two-sided) was considered significant for all the tests. Because blood glucose screening is routine for diabetic patients, all the diabetic respondents were removed from the sample. As a result, only 2,415 respondents were retained for analyses. The statistical analyses were conducted using Stata statistical software (release 9.2 (2005); StataCorp, College Station, TX, USA).

Table 1. Descriptive analysis of variables (n = 2,415)

Variables	Definition	n (%), or mean (SD)[a]
Outcome variable		
Blood glucose screening		
Yes	Used blood sugar test in the last 12 months	663 (27.5)
No	Did not use blood sugar test in the last 12 months	1752 (72.5)
Explanatory variables		
Age	Age (in years)	43.2 (10.48)[a]
Sex		
Male	Gender is male	988 (40.9)
Female	Gender is female	1427 (59.1)
Marital status		
Married	Marital status is married	2089 (86.5)
Unmarried	Marital status is single/divorced/widowed	326 (13.5)
Ethnicity		
Malay	Ethnicity is Malay	1337 (55.4)
Non-Malay	Ethnicity is non-Malay	1078 (44.6)
Education		
Tertiary	Education level is tertiary	211 (8.7)
Secondary	Education level is secondary	1266 (52.4)
Primary	Education level is primary	938 (38.8)
Income		
High	Monthly household income is ≥RM6000	58 (2.4)
Upper-middle	Monthly household income is RM3000–5999	232 (9.6)
Lower-middle	Monthly household income is RM1000–2999	907 (37.6)
Low	Monthly household income is ≤RM999	1218 (50.4)
Location of residence		
Urban	Urban dweller	1224 (50.7)
Rural	Rural dweller	1191 (49.3)
Family diabetes		
Yes	Immediate family members have diabetes	553 (22.9)
No	Immediate family members do not have diabetes	1862 (77.1)
Smoker		
Yes	Being a smoker	515 (21.3)
No	Being a non-smoker	1900 (78.7)
Body mass index (BMI)		
Obese	BMI ≥30	425 (17.6)
Overweight	25 ≤ BMI ≤ 29.9	732 (30.3)
At-risk	23 ≤ BMI ≤ 24.9	383 (15.9)
Normal	18.5 ≤ BMI ≤ 22.9	700 (29.0)
Underweight	BMI ≤ 18.4	175 (7.3)

[a]For age, the values refer to mean (standard deviation). For other variables, the values refer to sample size (percentage).

Results

Characteristics of the survey respondents are presented in Table 1. Less than one third of the respondents had their blood sugar measured in the last 12 months. The average age of the respondents is about 43 years. The majority of the respondents were female. A large proportion of the overall sample were married. Slightly more than half of the respondents were Malay.

About half of the respondents were in the low income group, followed by those in the lower-middle, upper-middle, and high income groups. The sample comprised an almost equal distribution of urban and rural dwellers. Approximately one fifth of the respondents' immediate family members have diabetes. A minority of the respondents were smokers (21.3%). The BMI breakdown comprised about one sixth of the respondents who are obese, about one

third overweight, and about one third of normal weight.

Results of the logistic regression analysis of using blood sugar test are illustrated in **Table 2**. About 72.80% of the outcomes were correctly predicted by the model showing good fit. Additionally, the results of LR and HL tests indicate that the model fits the data very well. Age was found to be positively associated with the likelihood of using blood sugar test (OR: 1.045; 95% CI: 1.034, 1.055). Married individuals have higher odds of using blood sugar testing than unmarried individuals (OR: 1.396; 95% CI: 1.033, 1.887). Compared to non-Malays, Malays are more likely to use blood sugar testing (OR: 1.254; 95% CI: 1.036, 1.519).

Higher odds of using blood sugar test are observed among individuals who are in high, upper-middle, and lower-middle income groups. Smokers show lower odds of using blood sugar test than non-smokers. Individuals who are obese, overweight, and normal weight are more likely to use blood sugar test than individuals who are underweight.

Table 2. Results of the logistic regression analysis of using blood sugar test (n = 2415)

Variables	Estimated Coefficient	Standard Error	Odds Ratio	95% CI	*P*
Constant	–4.08	0.365	–	–	<0.001
Age	0.04	0.005	1.05	1.03–1.06	<0.001
Gender					
Male	–0.02	0.114	0.98	0.79–1.23	0.880
Female	–	–	1.00	–	–
Marital status					
Married	0.33	0.154	1.40	1.03–1.89	0.030
Unmarried	–	–	1.00	–	–
Ethnicity					
Malay	0.23	0.098	1.25	1.04–1.52	0.020
Non-Malay	–	–	1.00	–	–
Education					
Tertiary	0.08	0.203	1.09	0.73–1.62	0.680
Secondary	0.18	0.115	1.20	0.96–1.51	0.110
Primary	–	–	1.00	–	–
Income					
High	1.11	0.294	3.03	1.70–5.38	<0.001
Upper-middle	0.86	0.171	2.36	1.69–3.29	<0.001
Lower-middle	0.32	0.110	1.38	1.11–1.71	0.0030
Low	–	–	1.00	–	–
Location of residence					
Urban	–0.14	0.099	0.87	0.72–1.06	0.160
Rural	–	–	1.00	–	–
Family diabetes					
Yes	0.18	0.112	1.20	0.96–1.49	0.110
No	–	–	1.00	–	–
Smoker					
Yes	–0.37	0.143	0.69	0.52–0.91	0.009
No	–	–	1.00	–	–
Body mass index (BMI)					
Obese	0.68	0.234	1.97	1.25–3.12	0.004
Overweight	0.62	0.223	1.86	1.20–2.89	0.005
At-risk	0.46	0.239	1.58	0.99–2.52	0.060
Normal	0.45	0.226	1.56	1.00–2.43	0.048
Underweight	–	–	1.00	–	–
LR χ^2 (16)	160.02	–	–	–	< 0.001
HL χ^2 (8)	10.58	–	–	–	0.230
Correct prediction (%)	72.8%				

CI = Confidence interval, LR = likelihood ratio, HL = Hosmer–Lemeshow.

Discussion

The nationally representative sample used in the present study allows an in-depth analysis of the socioeconomic and lifestyle factors associated with use of blood glucose screening. Applying a rigorous statistical model, the results show that age, marital status, ethnicity, income, smoking, and BMI are significantly correlated with use of blood glucose screening. Specifically, there exist positive relationships between the likelihood of using blood glucose screening and older individuals, being married, Malays, higher income earners, non-smokers, and being obese, overweight, and normal weight.

The findings of the present study suggest that older individuals are more likely to use blood glucose screening than their younger counterparts, which are somewhat consistent with those of previous studies conducted in Taiwan. For example, Hsieh and Lin [16] use data from the Taiwan Provincial Institute of Family Planning and find that older elderly people are more likely to use urine, blood pressure, and blood sugar tests than their younger peers. Tian et al [22] applied the 2003 Survey of Health and Living Status of the Elderly in Taiwan and observed a positive relationship between older individuals and use of preventive medical care services. The reasons for this outcome are straightforward. Because older individuals are more prone to suffering from diseases because of the biological process of aging, they are more motivated to use health screening. Young people also tend to take their health for granted, and consequently ignore the importance of health screening [23]. Therefore, we suggest that policy makers pay special attention to young people rather than the elderly, if the goal of increasing the utilization of health screening, particularly blood glucose screening is to be achieved.

Married individuals are more likely to use blood glucose screening than unmarried individuals. This finding is somewhat consistent with that of Deb [24]. We considered family-level variables in their analysis and found that presence of a spouse can significantly increase the probability of using blood pressure and cholesterol tests. More recent studies by Tian et al. [22] and Cheah [23] share similar findings. In particular, they find that marriage is positively associated with a higher likelihood of using health screening. Taken these findings together, we can conclude that married individuals display different decisions to use health screening from unmarried individuals given the presence of spouses or extended family commitments. As suggested by Cheah [23], married people tend to carry more responsibilities to look after their family than unmarried people, and are thus more aware of their own health. In terms of policy implication, an intervention strategy specifically targeted at the unmarried adults may be effective.

Ethnicity is found to be significantly associated with use of health screening, because Malays are more likely to use blood glucose screening than non-Malays. Dunn and Tan [10], Dunn et al. [11], and Dunn and Tan [12] found significant ethnic differences in use of cancer screening such as Pap smear and mammogram. Based on the current finding regarding ethnicity, one can conclude that Malays, the ethnic majority in Malaysia, are more aware of the benefits of using blood glucose screening than non-Malays. Perhaps, this is because information regarding health screening is often advertised to the public using Malay, the official language of Malaysia. However, given the limited availability of secondary data used in the present study, a better understanding of this explanation may be achieved by an in-depth qualitative study.

The findings regarding income are consistent with those of previous studies, which found income increases the use of health screening. For instance, Yi [25] uses a sample of Vietnamese women in Western Massachusetts and finds that women with lower income are less likely to use a Pap test than their higher income peers. Using similar outcome variables, Zhang et al. [17] found that women with a higher family income are more likely to use a Pap test than their peers with lower family income. Similar findings were reported by Abraido-Lanza et al. [18] after an examination of data from a National Health Interview Survey. That financial constraint is a high barrier to use of health screening may explain these findings, at least in part. Because expenditure on preventive medical care is unlikely to be paid by insurance or any third-party, especially in Malaysia, low income earners may tend to find health screening unaffordable. Therefore, in an effort to promote the use of health screening, particularly blood glucose screening among the poor, the government should consider subsiding the services at various hospitals and clinics.

Surprisingly, education was found to have insignificant relationship with use of blood glucose screening, which contradicts the findings reported by Kenkel [15] that education can increase an individual's likelihood of using health screening to improve health. The present study did not show any geographical

differences in use of blood glucose screening, which is somewhat inconsistent with Zhang et al. [17], who find that fewer rural than urban women undergo mammograms. Although Cheah and Tan [26] observed that a family history of chronic diseases such as hypertension, heart diseases and stroke can affect health-related behavior, the present study finds no significant relationship between presence of family history of diabetes and utilization of blood glucose screening.

The findings regarding lifestyle factors are interesting. On one hand, we found that smokers are less likely to use blood glucose screening than nonsmokers, which is consistent with findings of Lairson et al. [27] and Lin [21] who used a national sample of women veterans in the US and the National Health Interview Survey of Taiwan, respectively. Both these studies suggest that smoking significantly reduces the probability of using breast cancer screening. The notion is that smokers are generally more irrational and less concerned about their own health than nonsmokers and consequently display a lower preference for health investment, such as use of preventive medical care [21, 27]. On the other hand, we found that BMI has a positive effect on use of blood glucose screening. This may be because obese and overweight individuals are often told by health professionals that they have a high risk of developing various diseases. Therefore, they may be more willing to make better use of health screening to avoid diseases compared with their less corpulent peers. Additionally, individuals who are underweight may tend to be optimistic that they are unlikely to acquire diseases, and thus ignore the importance of health screening. An important implication of these findings is that public health authorities should make a concerted effort to promote use of blood glucose screening among smokers and underweight individuals.

The present study provides empirical evidence regarding nonusers of blood glucose screening. Specifically, young people, the unmarried, non-Malays, low income earners, smokers, and underweight individuals are identified as the non-users. Some brief discussions of these findings are in order. First, the young tend to have the perception that their risk of developing diabetes is low, and consequently ignore the importance of using blood glucose screening. Therefore, policies directed toward increasing health awareness among young people may be effective in promoting use of blood glucose screening. For instance, that diabetes is not a disease necessarily associated with the elderly should be well-advertised. Second, because of weak household commitment, unmarried individuals are unlikely to take their own health seriously. As a consequence, they tend to put a low effort into disease prevention. This finding implies that promoting marriage between young adults may be a good strategy for promoting their use of blood glucose screening. Third, the finding that non-Malays tend to be the nonusers of blood glucose screening reflects cultural differences in adoption of preventive measures against diabetes. Therefore, a public policy targeted towards encouraging use of blood glucose screening among non-Malays through language-based mass media may be effective. Fourth, low income earners tend to encounter financial difficulties, and thus lack the capability or priority to purchase health screening services. An implication of this finding is that intervention strategies that provide the poor with cost-reduced health screening services may help to increase the use of blood glucose screening. Finally, that smokers and underweight individuals are relative nonusers of blood glucose screening is not surprising. This may be because smokers are less conscious of their own health, whereas underweight individuals are optimistic about their health outcomes. As a result, they have a low tendency to undergo health examination. Policy recommendation in light of this finding is that government should introduce nationwide health awareness programmes with the aim of delivering information on disease prevention to smokers and underweight individuals.

Several inherent limitations of this secondary analysis of cross-sectional data are noted. First, numerous variables potentially affecting the use of health screening, such as, price of medical care, household size, and presence of children in a family are not considered in the present analysis. Second, although the data used in the present study is representative, it is not the most recent survey conducted by the Malaysian Ministry of Health. Despite these limitations, the present study sheds new light on the relationship between use of blood glucose screening and socioeconomic, and lifestyle factors.

Conclusion

In efforts to encourage the public to use blood glucose screening, it is essential to have a wide knowledge of which groups of individuals use or do

not use the services. Consistent with previous studies conducted in developed countries, the present study suggests that socioeconomic and lifestyle factors play an important role in the decision of people to use blood glucose screening. Therefore, appropriate direct intervention measures are needed to guarantee promising health outcomes.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

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