Trends in cardiovascular risk factors in diabetic patients in comparison to general population in Iran: findings from National Surveys 2007–2016

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To determine levels of change in risk factors for cardiovascular disease among people with and without a previous diagnosis of diabetes from 2007 to 2016 in Iran. Data were obtained from five rounds of the World Health Organization STEPwise approach to Surveillance (STEPS) cross-sectional surveys. Participants were 7665 and 93,733 adults with and without known diabetes, respectively, aged 25–65 years. We used logistic and linear regressions to assess the trends of risk factors. Individuals with known diabetes compared to those without the condition, experienced greater reductions in mean levels of systolic blood pressure (3.0 vs. 0.5 mmHg among women and 3.9 vs. 1.6 mmHg among men), diastolic blood pressure (6.4 vs. 5.11 mmHg in women and 3.3 vs. 1.8 mmHg in men), and non-HDL cholesterol (42.4 vs. 27.2 mg/dL among women and 30.3 vs. 21.0 mg/dL among men) throughout these years. Men with diabetes also showed a greater reduction in the prevalence of daily cigarette smoking compared to their non-diabetic counterparts (7.3% vs. 2.3%). Fasting plasma glucose decreased among subjects with diabetes but increased among those without diabetes. Significant increases were observed in proportions who met goals for blood pressure, triglycerides, non-HDL cholesterol and LDL cholesterol in both groups; however, almost half of diabetic subjects did not achieve risk factor goals in 2016. Secondary prevention in diabetic patients was more effective than primary prevention in the general population; however, the rate of diabetic patients who met the designated goals for each risk factor was still suboptimal.

Diabetes is associated with premature mortality from different causes, including cardiovascular diseases (CVD)1. Previous studies have demonstrated the vitality of CVD risk factor control to decrease the fast-rising trend of this mortality and CVD events in people with diabetes2–4. Furthermore, evidence suggests that the use of more intensive targets for blood pressure and cholesterol in individuals with diabetes results in a more significant reduction in the incidence of CVD events5–7. However, several studies report that people with diabetes are less likely to achieve target goals for control of CVD risk factors than those without diabetes8,9.

Nationally representative data that investigate trends in CVD risk factors in both the general population and people with diabetes in Middle Eastern countries such as Iran are scarce. Moreover, due to the lack of proper investigations that compare secular trends for CVD risk factors in individuals with and without diabetes in...

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this region, it is difficult to illustrate the impact of preventative programs on this population and also prioritize strategies for primary and secondary preventions. The primary goal of this analysis is to characterize and compare the trends of body mass index (BMI), waist circumference (WC), blood pressure, smoking, plasma glucose and lipid measures among adults with known diabetes (as indicators of secondary prevention impacts) and those without known diabetes (as indicators of primary prevention impacts) in a nationally representative study from 2007 through 2016.

**Results**

Age and sex distribution of participants with and without diagnosed diabetes in five STEPS surveys from 2007 to 2016.

|                      | STEPS-2007 | STEPS-2008 | STEPS-2009 | STEPS-2011 | STEPS-2016 |
|----------------------|------------|------------|------------|------------|------------|
| **N**                | 23,487     | 23,290     | 23,334     | 7551       | 23,738     |
| **Age, years**       | 44.3 ± 11.4| 44.2 ± 11.4| 44.7 ± 11.5| 44.4 ± 12.4| 42.3 ± 11.1|
| **Female, n (%)**    | 11,683 (49.7)| 11,539 (49.5)| 11,545 (49.5)| 4482 (59.4)| 12,437 (52.4)|
| **Known diabetes**   |            |            |            |            |            |
| **N, (%)**           | 1608 (6.8) | 1629 (7)   | 1571 (6.7) | 787 (10.4) | 2072 (8.7) |
| **Age, years**       | 52 ± 8.8   | 52.2 ± 8.6 | 52.8 ± 8.7 | 53.3 ± 9.9 | 50.7 ± 9.9 |
| **Female, n (%)**    | 968 (44.2) | 995 (46.1) | 1003 (63.8) | 518 (65.8) | 1278 (61.7) |
| **No known diabetes**|            |            |            |            |            |
| **N, (%)**           | 21,879 (93.2)| 21,661 (93)| 21,763 (93.3)| 6764 (89.6)| 21,666 (91.3)|
| **Age, years**       | 43.7 ± 11.3| 43.7 ± 11.4| 44.1 ± 11.4| 43.4 ± 12.4| 41.5 ± 10.9 |
| **Female, n (%)**    | 10,715 (49)| 10,544 (48.7)| 10,542 (48.4)| 3964 (58.6)| 11,159 (51.5)|

**Table 1.** Age and sex distribution of the participants with and without known diabetes in five STEPS surveys from 2007 to 2016.

In both sexes, diabetic individuals showed a greater reduction of mean SBP (3.0 vs. 0.5 mmHg in women and 3.9 vs. 1.6 mmHg in men), DBP (6.4 vs. 5.11 mmHg in women and 3.9 vs. 1.8 mmHg in men), LDL cholesterol (32.4
Figure 1. Trends of CVD risk factor levels among women with (red dotted line) and without diabetes (black dashed line) through 2007–2016. Changes in mean levels Body Mass Index (BMI), Waist Circumference (WC), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Daily cigarette smoking are presented for five STEPS surveys in 2007, 2008, 2009, 2011 and 2016. Changes in Fasting Plasma Glucose (FPG), Triglycerides (TGs), HDL cholesterol (HDL-C), non-HDL cholesterol (non-HDL-C) and LDL cholesterol throughout are presented for three STEPS surveys in 2007, 2011 and 2016.

vs. 21.1 mg/dL in women and 24.0 vs. 16.4 mg/dL in men), and non-HDL cholesterol (42.4 vs. 27.2 mg/dL in women and 30.3 vs. 21.0 mg/dL in men) compared to non-diabetics throughout 2007 to 2016 (Fig. 1).

Moreover, women without known diabetes showed an increase in FPG while there was a significant reduction among their counterparts. Waist circumference increased among men without known diabetes, while it remained unchanged among those with known diabetes (Fig. 1). Regarding meeting risk factor goals, women with diabetes had significantly more increase in the proportion that met goals of triglycerides compared to non-diabetic
women (29.4 vs. 15.8). Additionally, compared to non-diabetic men, those with diabetes had significantly more reduction in the prevalence of smoking from 2007 to 2016 (8.1% vs. 2.3%) (Fig. 2).

**Figure 2.** Trends of CVD risk factor levels among men with (red dotted line) and without diabetes (black dashed line) through 2007–2016. Changes in mean levels Body Mass Index (BMI), Waist Circumference (WC), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Daily cigarette smoking are preented for five STEPS surveys in 2007, 2008, 2009, 2011 and 2016. Changes in Fasting Plasma Glucose (FPG), Triglycerides (TGs), HDL cholesterol (HDL-C), non-HDL cholesterol (non-HDL-C) and LDL cholesterol throughout are presented for three STEPS surveys in 2007, 2011 and 2016.
Discussion

In this study, we assessed national trends of cardio-metabolic risk factors from 2007 to 2016 in Iran concerning diabetes status. We provided some evidence on the effects of national efforts for primary and secondary prevention of cardio-metabolic disorders in a Middle Eastern country. There were significant improvements in blood pressure levels, non-HDL lipids, and daily smoking in the Iranian population; however, a deterioration in levels of HDL cholesterol was observed among those with and without diabetes. Importantly, we found increasing levels of obesity measurements and FPG in those without diabetes. Our findings suggest that secondary prevention has been more successful than primary prevention in reducing risk factors as they showed that changes in blood pressure, non-HDL cholesterol, FPG, and obesity (only in men) were more favorable in those with diabetes than those without the condition. Despite improvements over the past decade, meeting CVD risk factor goals, particularly among those with diabetes, remained suboptimal as almost half of Iranians with diabetes did not achieve risk factor goals.

Our findings regarding improvements in blood pressure and non-HDL lipid levels are in line with those of previous studies on Iranian populations, showing similar decreasing trends\textsuperscript{10–12}. Notably, in this study, we had a higher proportion of participants, with and without diabetes who met goals of blood pressure and non-HDL lipids (53%-92%) compared with previous studies conducted in Iran (36%-87%)\textsuperscript{10–12}. Our findings are also in line with those of the Global Burden of Disease (GBD) and NCD Risk Factor Collaboration (NCD-RisC), which showed reductions in the burden of high blood pressure and dyslipidemia in the Middle East and Worldwide\textsuperscript{13–15}. Investigations from other countries have shown similar trends. Declines in mean SBP, DBP, LDL, non-HDL cholesterol and rate of smoking with more significant decreases among individuals with diabetes have been reported in studies from the National Health And Nutrition Examination Survey (NHANES) and the Framingham Heart Study in the US\textsuperscript{16,17} and the Health Survey for England\textsuperscript{18}. Accordingly, the prevalence of meeting blood pressure and LDL goals has been improved in the US\textsuperscript{16,17}. Decreasing trends in high blood pressure were also found in

| Table 2. Age-adjusted percentages of subjects with and without diagnosed diabetes who reached goals/ optimum levels of blood pressure, fasting plasma glucose and lipid measures. *Known diabetes mellitus. |
|-----------------|-------------|-------------|-------------|-----------------|-----------------|-----------------|
|                  | STEPS-2007  | STEPS-2011  | STEPS-2016  | P-trend         | P-interaction   |
|                  | n           | % (SE)      | n           | % (SE)         | n              | % (SE)         |
| **Women**        |             |             |             |                 |                 |
| Blood pressure < 140/90 mmHg |             |             |             |                 |                 |
| KDM*             | 403         | 47.0 (1.9)  | 211         | 44.8 (2.7)     | 661             | 57.9 (1.6)     | < 0.001         | 0.555           |
| Non-KDM          | 7429        | 74.6 (0.5)  | 2881        | 78.2 (0.7)     | 8867            | 84.1 (0.4)     | < 0.001         |                 |
| Fasting plasma glucose < 130 mg/dL |             |             |             |                 |                 |
| KDM              | 459         | 49.2 (1.8)  | 191         | 37.5 (2.4)     | 677             | 54.7 (1.5)     | < 0.001         | 0.12            |
| Non-KDM          | 8665        | 84.6 (0.4)  | 2934        | 76.9 (0.7)     | 8036            | 80.9 (0.4)     | < 0.001         |                 |
| Fasting plasma glucose < 100 mg/dL |             |             |             |                 |                 |
| KDM              | 200         | 19.4 (1.4)  | 136         | 24.7 (2.1)     | 218             | 16.8 (1.1)     | 0.032           | 0.532           |
| Non-KDM          | 2652        | 24.4 (0.5)  | 1297        | 31.4 (0.8)     | 2649            | 23.1 (0.4)     | 0.044           |                 |
| HDL cholesterol > 50 mg/dL |             |             |             |                 |                 |
| KDM              | 203         | 21.4 (1.5)  | 153         | 30.4 (2.3)     | 715             | 58.1 (1.5)     | < 0.001         | 0.724           |
| Non-KDM          | 6890        | 67.6 (0.5)  | 2997        | 78.6 (0.7)     | 10,003          | 91.5 (0.3)     | < 0.001         |                 |
| Non-HDL cholesterol < 130 mg/dL |             |             |             |                 |                 |
| KDM              | 349         | 36.3 (1.7)  | 179         | 35.9 (2.4)     | 807             | 65.7 (1.4)     | < 0.001         | 0.011           |
| Non-KDM          | 7038        | 67.6 (0.5)  | 2682        | 70.1 (0.8)     | 9142            | 83.4 (0.4)     | < 0.001         |                 |
| **Men**          |             |             |             |                 |                 |
| Blood pressure < 140/90 mmHg |             |             |             |                 |                 |
| KDM              | 321         | 54.7 (2.4)  | 122         | 50.74 (3.6)    | 452             | 61.5 (2.0)     | 0.007           | 0.019           |
| Non-KDM          | 8138        | 76.7 (0.5)  | 2085        | 79.5 (0.9)     | 2338            | 83.6 (0.4)     | < 0.001         |                 |
| Fasting plasma glucose < 130 mg/dL |             |             |             |                 |                 |
| KDM              | 314         | 50.6 (2.2)  | 106         | 40.6 (3.4)     | 377             | 47.6 (2.0)     | 0.554           | 0.003           |
| Non-KDM          | 9233        | 83.7 (0.4)  | 1952        | 74.3 (0.9)     | 8103            | 78.0 (0.4)     | < 0.001         |                 |
| Fasting plasma glucose < 100 mg/dL |             |             |             |                 |                 |
| KDM              | 290         | 43.6 (2.2)  | 116         | 38.8 (3.3)     | 199             | 23.2 (1.6)     | < 0.001         | 0.189           |
| Non-KDM          | 5490        | 46.8 (0.5)  | 1557        | 54.6 (1.1)     | 3537            | 32.2 (0.5)     | < 0.001         |                 |
| HDL cholesterol > 40 mg/dL |             |             |             |                 |                 |
| KDM              | 157         | 25.6 (2.0)  | 77          | 27.9 (3.0)     | 472             | 59.2 (2.0)     | < 0.001         | 0.666           |
| Non-KDM          | 7768        | 71.0 (0.5)  | 2220        | 81.1 (0.8)     | 9429            | 90.7 (0.3)     | < 0.001         |                 |
| LDL cholesterol < 130 mg/dL |             |             |             |                 |                 |
| KDM              | 156         | 26.0 (2.0)  | 76          | 27.8 (3.0)     | 456             | 57.5 (2.0)     | < 0.001         | 0.853           |
| Non-KDM          | 8123        | 74.3 (0.5)  | 2319        | 84.5 (0.7)     | 9611            | 92.4 (0.3)     | < 0.001         |                 |
| Triglycerides < 150 mg/dL |             |             |             |                 |                 |
| KDM              | 244         | 38.7 (2.2)  | 91          | 32.0 (3.1)     | 428             | 53.4 (2.0)     | 0.015           | 0.966           |
| Non-KDM          | 6712        | 59.6 (0.5)  | 1764        | 63.2 (1.0)     | 7726            | 74.0 (0.5)     | < 0.001         |                 |

Investigations from other countries have shown similar trends. Declines in mean SBP, DBP, LDL, non-HDL cholesterol and rate of smoking with more significant decreases among individuals with diabetes have been reported in studies from the National Health And Nutrition Examination Survey (NHANES) and the Framingham Heart Study in the US\textsuperscript{16,17} and the Health Survey for England\textsuperscript{18}. Accordingly, the prevalence of meeting blood pressure and LDL goals has been improved in the US\textsuperscript{16,17}. Decreasing trends in high blood pressure were also found in
pressure and serum lipid levels. Previous studies showed that Iranian families had reduced the consumption of hydrogenated oil and salt, which could explain the favorable blood pressure and lipid trends in Iranians. Further, previous studies showed increasing use of anti-hypertension and lipid-lowering drugs among Iranian adults. Nevertheless, the decreasing trends in blood pressure and lipid levels in our population could hardly be explained by an increase in physical activity, since it was shown that low physical activity is common in Iranian community.

Notably, by showing a significant reduction in the prevalence of daily smoking among those without known diabetes, this study suggests that efforts for lowering the prevalence of smoking have been successful in controlling the increasing trends. The decrease in the prevalence of daily smoking in this group might also contribute to the decline in non-HDL lipid and blood pressure given the substantial evidence on the positive correlation of smoking with high blood pressure and dyslipidemia.

On the contrary, we showed a rise in levels of obesity measurements in individuals without known diabetes (WC in both genders and BMI in men), which is probably the main reason for the increasing fasting plasma glucose trends in this group. Contrary to the results of the previous studies that showed growing trends for HDL cholesterol in Iranian population, this study showed a significant reduction in HDL cholesterol in those with and without diabetes. As shown in previous studies, decreasing levels of HDL cholesterol are mostly due to poor dietary habits and low levels of physical activity. Deterioration in obesity measurements and HDL cholesterol levels should raise the alarm for policymakers as it indicates efforts for improvement of dietary habits and physical activity came short in this Iranian population. Based on previous studies in Iran, the most important barriers to healthy nutrition and physical activity were interpersonal/cultural effects, lack of access to healthy foods, food preferences, media advertisements, nutrition transition, lack of time, motivation and prioritizing other activities over sports and high costs of the facilities. Therefore, feasible and effective national intervention programs are needed to curb current obesity epidemics by overcoming the barriers to healthy nutrition and physical activity. Despite the promising findings of several community-wide lifestyle intervention programs in Iran, such as Tehran Lipid and Glucose Study and Isfahan Healthy Heart Program, these programs did not scale up in national levels.

In accordance with the evidence showing a correlation between diabetes and other cardio-metabolic risk factors, we showed risk factor levels were higher in those with diabetes compared to those without it. Our findings support that the efforts on controlling blood pressure, dyslipidemia and obesity had more impacts among people with diabetes rather than non-diabetics. First of all, this is because diabetic patients experienced more reduction in mean SBP, DBP and non-HDL lipids. In addition, their obesity and blood glucose measurements remained steady, while people without diabetes showed a significant increase in obesity measurements. Favorable trends in dyslipidemia, obesity and blood glucose control in known diabetics may be due to improvements in care, knowledge and attitude towards diabetes as well as better adherence to lifestyle and pharmaceutical interventions. Previous studies show advancements in the quality of diabetes care, affordability of medications, and screening for undiagnosed diabetes as well as increasing trends in consumption of glucose-lowering (twofold in men and 1.5-fold in women) and lipid-lowering drugs (fourfold in men and 2.5-fold in women) among those with known diabetes. Educational interventions in Iran, such as Self-Management Education (PDSME) program, also proved to be effective in improving the knowledge and practice of diabetes, which is highly correlated with control of related risk factors.

Nevertheless, in this study, the prevalence of daily smoking remained steady in participants with diabetes, while its prevalence reduced significantly in those without the disease. These findings are in contrast with those of a previous study that showed an increasing trend for smoking in those with diabetes was significantly higher than increases in smoking prevalence in those without diabetes. This discrepancy may indicate favorable and radical changes in the prevalence of smoking. Another explanation may be the differences in the study sample and definition of smoking in this study compared to the previous studies, which were mostly cohort studies with local study samples and various definitions of smoking. Further research is needed to provide more robust evidence on trends for smoking prevalence in Iran.

Since, during the last decades, the highest number of STEPS surveys in the Middle East have been conducted in Iran, it was made possible to investigate the secular trend of CVD risk factors using national data for the first...
time in this region. Standardized measurement methods throughout the study period were used and large sample sizes and multiple measurements led to high precision in estimating the prevalence and trends of different risk factors. However, there are some limitations. We only assessed these trends for 10 years. Although the sampling methods were representative of the Iranian population, there were some minor differences that were addressed using post-stratification weighting based on age, sex, region and province categories of population in 2011 as a reference for all years. Finally, the biochemical measurements were only available for three STEPs cycles.

**Conclusion**
Non-HDL lipids and blood pressure levels in the Iranian population improved significantly in those with and without diabetes. Moreover, obesity measurements and fasting plasma glucose worsened in diabetic persons. This study showed favorable changes in blood pressure, non-HDL cholesterol, blood glucose, and obesity (only in men) were more prominent in people with diabetes compared to those without known diabetes. This indicating secondary prevention efforts have been more effective than primary prevention in Iran.

**Methods**
This study is conducted on the data documented from five STEPwise approaches to Surveillance (STEPS) surveys (2007, 2008, 2009, 2011, and 2016). The first STEPS in 2005 was not included due to the inconsistency of some measurement methods. STEPS is a standardized survey designed to help the World Health Organization (WHO) member states collect and disseminate consistent data about non-communicable diseases (NCD) and enable comparisons over time. A brief explanation of the samplings of the surveys is presented as follows.

All methods in the current study were carried out following relevant guidelines and regulations, the Center for Disease Control, Ministry of Health and Medical Education in Iran approved all experimental protocols, and all participants gave informed consent.

**Study population.** Using random cluster sampling methods based on instructions of WHO for STEPS, 23,487, 23,290, 23,334, 7551, and 23,738 adults, aged 25–65, were selected in 2007, 2008, 2009, 2011 and 2016, respectively. Despite differences in design and sampling methods, all surveys represented the Iranian population. Socio-demographic information and physical measurements were collected in all five surveys, whereas biochemical measurements were collected only in 2007, 2011 and 2016.

The sampling method in 2007, 2008 and 2009 was similar. The sampling was conducted at levels of towns, villages and districts of large cities using a randomized cluster sampling scheme. In each province, 1000 individuals were selected in 50 clusters. Each cluster included 20 individuals, 10 women and 10 men, living in neighboring households.

The 2011 survey used a multistage cluster random sampling scheme. At the first stage, distinct counties or a group of adjacent counties were listed as the primary sampling units (PSU). Fifty PSUs were then picked by applying probability proportionate to size (PPS) random sampling. Within each PSU, urban and rural areas were listed as possible secondary sampling units (SSU) from which twelve SSUs were picked by employing the PPS method similar to the previous step. In the third stage, a list of households in each SSU referenced by their 10-digit postal addresses was developed, of which twenty postal addresses were selected randomly. At the final stage, one individual was selected from each selected household using Kish tables provided by WHO, and they were interviewed at their houses.

In 2016, a systematic cluster random sampling scheme was designed to select 31,050 individuals in 3105 clusters (10 subjects from each cluster) from urban and rural areas of all provinces. To estimate the minimum sample size at the province level, calculations were based on the province with the lowest population density. The sample size in other provinces was determined according to their population ratio to that province. To control non-response errors and mind the effect of sampling design, 10% was added to the estimated sample size of each province. Also, to minimize costs, in more crowded provinces (those with more than 800 clusters), half of the estimated sample size was considered, but the applied weight in the subsequent analysis was doubled.

**Medical history, clinical examination and laboratory measurements.** Standard questionnaires based on the WHO STEPS were used to collect demographic information as well as the past medical history of diabetes, medication use and cigarette smoking. Blood pressure was measured three times at five-minute intervals. The average of second and third readings was considered as the participants’ blood pressure.

All biochemical measurements were assessed in venous samples drawn after 12–14 hours overnight fasting according to a standard protocol and sent to collaborating centers. In 2007 and 2011, Fasting Plasma Glucose (FPG) was measured with enzymatic colorimetric methods with a glucose oxidase test and serum lipids, including total cholesterol, high-density lipoprotein (HDL) cholesterol and triglycerides were determined by enzymatic methods (Pars Azmun, Karaj, Iran). In 2016, venous samples were transferred to the Central Reference Laboratory in Tehran and all laboratory tests were measured using the auto analyzer (Cobas C311 Hitachi High–Technologies Corporation) approved by Reference Laboratory. Low-density lipoprotein (LDL) cholesterol was calculated by the modified Friedewald equation to be consistent among all STEPS surveys.

**Definition of terms.** Known diabetes was defined as a positive response to either of the two following questions: (1) “Have you ever been told by a doctor or other health worker that you have diabetes?” and (2) “Are you currently taking insulin or oral medication for diabetes prescribed by a doctor or other health worker?”. Hypertension goal/optimum level was defined as mean systolic blood pressure (SBP) < 140 mmHg or mean diastolic blood pressure (DBP) < 90 mmHg. Participants who smoked cigarettes daily were considered ‘daily smokers’. Glycemic control was defined as a goal of FPG < 130 mg/dL in diabetic subjects and an optimum level
of FPG < 100 mg/dL in non-diabetic subjects. Goals/optimum levels for non-HDL cholesterol and LDL cholesterol were defined as non-HDL cholesterol < 130 mg/dL and LDL cholesterol < 100 mg/dL in those with known diabetes and non-HDL cholesterol < 160 mg/dL and LDL cholesterol < 130 mg/dL in those without known diabetes. Goals/optimum levels for HDL cholesterol were defined as ≥ 50 mg/dl for women and ≥ 40 mg/dl for men and for triglycerides were defined as triglyceride < 150 mg/dl in both genders.47,48.

**Statistical analysis.** Characteristics of the study population were described by mean (SE) values for continuous variables and frequency (%) for categorical variables after accounting for the survey nature of the data. Since about 10% of the data were missed, the multiple imputation method was used for the estimation of missing information. Five imputation sets were performed to impute missing information of FPG, TG, total cholesterol, BMI, and blood pressure, using sex, area of living, and age as auxiliary variables. Survey analysis was performed in Stata ver. 12 and the results of all STEPS were weighted using “poststratum weights” according to the national Iranian census in 2011; “poststrata” was defined based on categories of age (25–44 years, 45–64 years), sex, residential area (rural, urban) and the provinces; in this way, the results of all STEPS would be comparable.

The trend of prevalence rates and averages of risk factors in diabetic and non-diabetic subjects were examined separately using logistic and linear regressions. The interaction between the trend of risk factors and diabetes status was evaluated by adding the interaction term of time × diabetes to the models in pooled data from diabetic and non-diabetic subjects.

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Author contributions
H.M., M.L. and D.K. carried out the initial analysis and interpretation of data and drafted the manuscript. D.K. and F.H. supervised the study and approved the contents of the manuscript. A.O. and M.Y. coordinated and supervised the STEPS surveys and F.F. and F.A. critically reviewed the manuscript.

Competing interests
The authors declare no competing interests.

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