BMJ Open

Prevalence of diabetes mellitus and associated risk factors in Nepal: findings from a nationwide population-based survey

Namuna Shrestha ,[1] Khem Karki,[2] Anil Poudyal ,[1] Krishna Kumar Aryal,[3] Namra Kumar Mahato,[1] Nitisha Gautam,[1] Dirghayu KC ,[3] Pradip Gyanwali,[1] Meghnath Dhimal ,[1] Anjani Kumar Jha[1]

To cite: Shrestha N, Karki K, Poudyal A, *et al*. Prevalence of diabetes mellitus and associated risk factors in Nepal: findings from a nationwide population-based survey. *BMJ Open* 2022;**12**:e060750. doi:10.1136/bmjopen-2022-060750

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-060750).

NS and KK contributed equally.

Received 03 January 2022
Accepted 02 February 2022

[1]Research Section, Nepal Health Research Council, Kathmandu, Nepal
[2]Department of Community Medicine, Maharajgunj Medical Campus, Kathmandu, Nepal
[3]Public Health Promotion and Development Organization, Kathmandu, Nepal

Correspondence to
Ms Namuna Shrestha;
namunashrestha12@gmail.com

ABSTRACT

Objectives The burden of diabetes mellitus (DM) has increased globally, particularly in low-income and middle-income countries, including Nepal. Population-based nationally representative data on the prevalence of DM is limited. This paper presents the prevalence of DM and its associated risk factors in Nepal.

Research designs and methods This population-based study sampled 13 200 participants aged 20 years and above in 400 clusters of 72 districts of Nepal. The study used a standardised questionnaire adapted from the WHO STEPwise approach to non-communicable disease risk factor surveillance instrument and digitalised in Android-compatible mobile phones. Fasting and 2 hours postprandial blood samples were taken to test various biochemical parameters. Descriptive followed by multivariate analyses were done to assess the association between explanatory variables and the outcome variable.

Primary outcome measures Prevalence of DM.

Results The prevalence of DM was found to be 8.5% (95% CI 7.8% to 9.3%). The odds of DM occurrence were higher in the upper age groups (40–59 years at adjusted OR (AOR) 3.1 (95% CI2.3 to 4.2) and 60+ years at AOR 4.7 (95% CI 3.3 to 6.6)), compared with the group aged 20–39 years. Men were found to have higher odds of DM (AOR 1.3, 95% CI 1.1 to 1.6) compared with women. Urban residents had almost twice higher odds of DM (AOR 1.7, 95% CI 1.4 to 2.2) compared with rural residents. Participants with raised blood pressure (BP) (AOR 2.2, 95% CI 1.8 to 2.7), those who were overweight and obese (AOR 2.0, 95% CI 1.6 to 2.4) and those who had high triglycride level (≥150 mg/dL) (AOR 2.1, 95% CI 1.8 to 2.6) also had twice higher odds of DM compared with those with normal BP, an average body mass index and normal triglyceride level, respectively.

Conclusions Targeted interventions to higher risk groups as well as prevention and control of other associated biological risk factors might help to reduce the prevalence of DM in Nepal.

Strengths and limitations of this study

- The study included a large sample spread across 400 clusters (wards-lowest administrative units) covering 72 districts out of 77 districts in Nepal.
- Blood glucose was measured through both fasting and postprandial blood sample.
- The study used digital data collection and feedback was given on a regular basis after data were uploaded on a real-time basis.
- Data quality was ensured through standard training processes and quality assurance procedures.
- The study does not have information on the physical activity and dietary habits of participants, which are known to be important predictors of diabetes mellitus.

INTRODUCTION

The burden of diabetes mellitus (DM) has increased globally. In 2019, approximately 463 million adults aged 20–79 years were living with diabetes worldwide,[1] causing an estimated 1.5 miliion deaths.[2] This number is expected to rise to 700 million by 2045[1] DM contributes to at least US$727 billion in health expenses, with 12% of total spending on adults.[3] The burden of DM in terms of prevalence and number has risen dramatically, particularly in low-income and middle-income countries.[4]

The prevalence of DM and related risk factors, including overweight and obesity, has increased across South Asia in recent decades.[5] According to the International Diabetes Federation (IDF), an estimated 82 million adults aged 20–79 years were living with DM in the South East Asia Region in 2017, representing a regional prevalence of 8.5%.[6] Factors like decline in nutrition quality, reduction in physical activity and increase in sedentary behaviours are reflected in the increasing prevalence of type 2 diabetes and related risk factors in the region.[5] The IDF reported the national prevalence of DM among people 20–79 years in

Nepal to be 4% in 2017, which is expected to rise to 6.1% by 2045. In the same age group, 11.7% of total deaths were attributed to DM in Nepal.[7] A systematic review carried out in 2014 showed a pooled prevalence of DM as 8.4%, with the variation in prevalence ranging from 1.4% to 19.0% in Nepal.[8] Even though, there are several national estimates available on the prevalence of DM in Nepal,[9–12] those studies were limited to small sample size or geographic location that would not be representative of the whole population in Nepal. In addition, criteria used for defining the prevalence of DM varied across studies. Furthermore, there is a lack of research identifying the predictors of type 2 diabetes in Nepal.[9] This warrants a large scale study that is representative of the whole population, which provides a national (including subnational) prevalence of type 2 diabetes using standard criteria and identifies its predictors.

This study reports the first nationally representative population-based prevalence of DM measured through both fasting and postprandial (PP) blood sample including that in different subgroups and factors associated with occurrence of DM in Nepal.

METHODS

A population-based cross-sectional study was conducted covering all seven provinces of Nepal from 2016 to 2018. The sample size was calculated by considering the prevalence of raised blood glucose (p=4%) from the 2013 non-communicable diseases (NCD) risk factors STEPS survey, Nepal.[13] The study was carried out among 13 200 participants aged 20 years and above using mutlisatge cluster sampling technique. Men and women not providing consent to participate in either or both stages of the study (questionnaire and physical measurements, or biochemical measurements) were excluded from that particular stage or both the stages depending on the consent received. Detail methodology for this study has been explained elsewhere.[14]

Data collection

Data collection was done in two steps: first as face-to-face interview with a questionnaire and as second step physical measurements and collection of blood sample of the same participant with the prior appointments. Additional details on data collection such as orientation of field team has been explained previously.[14] REMO-Research and Monitoring Software, was used to programme the questionnaires into the mobile phones. This software was developed by Rooster Logic, an Information and Communication Technology company led by local engineers with focus on database creation and management, research, and monitoring. This software has been extensively used for digital data collection in Nepal and allows small to large scale research projects to be conducted with ease and enables real-time monitoring of data. This software has been used by the Nepal Health Research Council in various previous surveys.[15 16]

Sociodemographic and behavioural information

Information on sociodemographic and behavioural risk factors was collected through face-to-face interviews using an interviewer-administered questionnaire. Information was collected on age, sex, ethnicity, educational status, marital status, occupation type, history of raised blood pressure and DM, alcohol consumption, and smoking habits. The commonly used classification for ethnicity in Nepal has six categories: (1) Dalit (marginalised group of people, with relatively lower socioeconomic and education status); (2) Disadvantaged Janajatis (disadvantaged group of people and also indigenous, with relatively lower socioeconomic and education status); (3) Disadvantaged non Dalit Terai Caste Groups (disadvantaged group of people from the Terai, the lowlands, with relatively lower socio-economic and education status but not the dalit groups); (4) Religious Minorities (Muslim, Christian, etc); (5) Relatively advantaged Janajatis (indigenous group of people with relatively higher socioeconomic status, such as Newar, Thakali and Gurung) and (6) Upper Caste Groups (population with relatively higher socioeconomic and education status, mostly Brahmins, Chhetris and Thakuri).[17]

Data on part of physical measurements, blood pressure measurement and biochemical measurement were done using respective equipment and procedures, and the detail including the information on quality control has been explained elsewhere.[14] Participants were defined as having DM if they had raised fasting glucose (≥126 mg) or raised PP blood glucose level ((≥200 mg), or if the participants were on anti-diabetic medication at the time of the study[18 19] whereas the key definition of the terms raised blood pressure, body mass index (BMI), tobacco use and alcohol consumption has been explained in the report published previously.[14]

Data management and analysis

Data were extracted by the core team involved in data management, from the server where the collected data were stored. Data cleaning was performed using IBM SPSS Statistics software V,20.0 (IBM). The cleaned data were then exported to Stata V.13.0 for analysis (Stata). Descriptive results were produced for each of the outcome variables using complex sample analysis considering the PSUs, strata and weight. Bivariate and multivariate analyses were used to assess the association between explanatory variables and the outcome variable. All explanatory variables with $p<0.05$ in the bivariate analysis were inserted in the multivariate binary logistic regression model to see the independent effect of each variable on the occurrence of DM. The magnitude of the association was measured using the adjusted odds ratio (AOR) and 95% CI. A $p<0.05$ was considered as statistically significant.[20]

Patient and public involvement statement

There was no involvement of patient in the study conception or design. However, experts in the relevant field were involved from the beginning and regular consultation

Table 1 Sociodemographic characteristics of the participants

Variables	Characteristics (N=12 557)	N	%
Age	20–39	4562	35.5
	40–59	5186	41.3
	60 years and above	2809	23.3
Sex	Male	4908	42.2
	Female	7649	57.9
Ethnicity	Upper caste groups	4263	32.7
	Disadvantaged janajatis	2656	20.7
	Relatively advantaged janajatis	2077	17.0
	Disadvantaged non-dalit terai caste groups	1900	17.0
	Dalits	1298	9.6
	Religious minorities	363	2.9
Education	Illiterate/no formal schooling	6820	53.1
	Below secondary (<10 years)	2839	22.3
	Secondary and above (≥10 years)	2898	24.6
Province	Province 1	2185	17.6
	Province 2	2083	18.4
	Bagmati province	3223	24.7
	Gandaki province	1337	9.6
	Province 5	2070	15.9
	Karnali province	601	4.8
	Sudurpaschim province	1058	9.1
Place of residence	Rural	6300	48.5
	Urban	6257	51.5

was done with them. The findings from the study were disseminated to the general public and concerned stakeholders through a dissemination programme.

RESULTS

The following section describes the results. It is divided into a descriptive picture of sociodemographic, behavioural and biological characteristics, and followed by the factors associated with the occurrence of DM.

Sociodemographic characteristics

Out of the 13 200 targeted participants, 12 557 (95.3%) participated in the interview with a questionnaire (step 1), and 12 148 (92%) participated for the physical measurements and laboratory investigations (step 2). Sociodemographic characteristics of the participants are presented in table 1. Among total of 12 557 participants, the majority of participants (76.8%) were in the age group 20–59 years. More than half of the participants (57.9%) were female. More people belonged to the upper caste groups (32.7%), followed by disadvantaged janajatis (20.7%). More than half (53.1%) were illiterate or never had formal schooling. Geographically, about one-fourth of the participants were from Bagmati province (24.7%), as it contained the capital city with dense population with the lowest proportion from Karnali province (4.8%). More than half (51.5%) of the participants were urban dwellers.

Behavioural and biological characteristics

About one-third of the participants (31.9%) said that they were smokers. Nearly one-fourth of the participants (24.6%) reported that they were current alcohol drinkers. Raised blood pressure was prevalent among 36.9% of the participants. The proportion of participants who were either overweight or obese was 30.7%. More than one-third (35.7%) of participants had raised triglycerides. Behavioural and biological characteristics of the participants are presented in table 2.

Factors associated with DM

The overall prevalence of DM was 8.5% (95% CI 7.8% to 9.3%). The following two tables (tables 3 and 4) show the results on factors associated with DM, along with prevalence of DM among the different subgroups examined. Table 3 shows the prevalence of DM across subgroups by different background characteristics, and the factors associated with occurrence of DM through multivariate analysis in terms of AOR. The prevalence of DM is seen to have increased with age. Participants in the age group of 60 years and above had about five times higher odds of having DM (AOR 4.7, 95% CI 3.3 to 6.6) compared with those in the age group of 20–39 years. Similarly, male participants had higher odds of having DM (AOR 1.3, 95% CI 1.1 to 1.6) compared with female participants. Urban residents had about two times higher odds of having DM (AOR 1.7, 95% CI 1.4 to 2.2) compared with those residing in rural area. Table 4 shows the prevalence of DM across subgroups by different behavioural and biological characteristics and the factors associated with occurrence of DM through multivariate analysis in terms of AOR. Participants with raised blood pressure had about two times higher odds of having DM compared with those whose blood pressure was normal (AOR 2.2, 95% CI 1.8 to 2.7). Regarding BMI, participants who were overweight and obese had two times higher odds of having DM than those with normal BMI (AOR 2.0, 95% CI 1.6 to 2.4). Participants who had high triglyceride level (≥150 mg/dL) had about two times higher odds of having DM than their counterparts (AOR 2.1, 95% CI 1.8 to 2.6).

DISCUSSION

The first nationally representative study identified high prevalence of DM among the participants, which is higher than the IDF's estimate for Nepal, that is, 4% in 2017.[21] However, the prevalence of DM is similar to the

Table 2 Behavioural and biological characteristics of the participants

Variables	Characteristics (N=12 557)	N	% (95% CI)
Smoking habit	Smokers	3955	31.9 (30.3 to 33.5)
	Non-smoker	8602	68.1 (66.5 to 69.7)
Users of smokeless tobacco products	Users	3087	25.4 (24.1 to 26.8)
	Non-users	9470	74.6 (73.3 to 75.9)
Users of either smoke or smokeless tobacco products	Users	1609	13.1 (12.2 to 14.1)
	Non-users	10 948	86.9 (86.0 to 87.8)
Alcohol consumption	Yes	3115	24.6 (22.98 to 26.3)
	No	9442	75.4 (73.7 to 77.02)
Blood pressure	Raised	4504	36.9 (35.4 to 38.5)
	Normal	8053	63.1 (61.6 to 64.6)
Body mass index (N=12 556)	Underweight	1534	12.3 (11.3 to 13.4)
	Normal	7156	57.0 (55.6 to 58.5)
	Overweight and obese	3866	30.7 (28.9 to 32.5)
Increased waist hip ratio (N=11 997)	Increased	6896	55.3 (53.9 to 56.7)
	Normal	5101	44.7 (43.4 to 46.1)
Total cholesterol (N=10 861)	Raised	3120	28.8 (27.3 to 30.4)
	Normal	7741	71.2 (69.6 to 72.7)
Triglyceride (N=10 986)	Raised	3862	35.7 (34.2 to 37.2)
	Normal	7124	64.3 (62.8 to 65.9)

findings observed in a systematic review (pooled prevalence—8.4%, 95% CI 6.2% to 10.5%), which summarised the prevalence of type 2 diabetes in Nepal for a period of 14 years.[8] Similar figure (8.5%, 95% CI 6.9% to 10.4%) was reported in another systematic review conducted in Nepal.[22] Our finding is also in line with the WHO estimates for DM in Nepal which reported a prevalence of 9.1% in 2016.[23] The latest estimates from the global burden of disease study, however, show a national prevalence of 4.4% of diabetes type 2.[24] Likewise, WHO global report on DM also estimated a regional prevalence of 8.6% in South East Asia in 2014, which is consistent with the findings from our study.[4] The finding from our study is similar to estimates of DM prevalence from different studies in the neighbouring countries, including India (8.7%),[25] China (10.9%),[26] Sri Lanka (8.4%), Bhutan (7.7%), Maldives (7.5%) and Bangladesh (6.8%).[21] The prevalence of DM in our study may be attributed to a combination of factors including rapid urbanisation, changing lifestyles, unhealthy diets, tobacco use, and increasing life expectancy. Adding to this, several challenges prevailing around diabetes management such as high treatment cost, availability of limited health facilities, lack of awareness about the disease and particularly no specific guideline available for the prevention and treatment of the disease in Nepal might have exacerbated the burden of this disease.[10]

Our study reports that age was significantly associated with DM, with older aged people (60 years and above) having higher odds of having DM. Older age as an important predictor for DM is consistent with the findings of studies from different contexts.[8 9 27–30] The life expectancy of Nepalese people has increased from 58 years in 1990 to 71 years in 2019[24] and the proportion of the older population is growing,[31] which further tends to increase in future.[32] With ageing, skeletal muscle insulin sensitivity might be impaired which in turn increase the risk of insulin resistance and type 2 diabetes.[33] The findings of the study and these factors underscore the need of tailored interventions for management and control of DM among population with higher age. Further to this our study showed that, male had higher odds of having DM than females. This finding is supported by an another study conducted in Nepal, which identified being female as significant protective factor for DM (AOR 0.4, 95% CI 0.3 to 0.7).[9] A systematic review conducted in South Asia also supported the findings from our study, indicating being male as a significant risk factor for DM.[34] However, this is in contrast to the findings reported in a different systematic review suggesting that females were at higher risk of DM in Nepal (OR 1.6, 95% CI 1.3 to 1.9).[8] Higher prevalence of DM among men has been associated with large amount of visceral fat in men.[35] Besides, lower tendency of women to develop visceral adiposity may explain that women are protected from DM in comparison to men.[36]

Our study reported that urban residents were more likely to have DM compared with those residing in rural areas. Nepal has been experiencing an increasing rate in urbanisation.[37] Increasing urbanisation leading to

Table 3 Association of sociodemographic factors with diabetes mellitus (DM)

Variables and characteristics	No of participants	Proportion with DM (%)	Odds of having DM	
			COR (95% CI)	AOR (95% CI)
Age				
20–39	4046	115 (3.0)	1	1
40–59	4723	469 (10.4)	3.7 (2.9 to 4.9)***	3.1 (2.3 to 4.2)***
60 years and above	2508	300 (13.3)	4.9 (3.7 to 6.5)***	4.7 (3.3 to 6.6)***
Sex				
Female	6952	436 (6.7)	1	1
Male	4325	448 (11.0)	1.7 (1.5 to 2.0)***	1.3 (1.1 to 1.6)**
Ethnicity				
Disadvantaged janajatis	1130	68 (6.6)	1	1
Dalits	2369	151 (6.7)	1.0 (0.7 to 1.4)	1.3 (0.8 to 1.9)
Disadvantaged non-dalit terai caste groups	1690	127 (8.4)	1.3 (1.0 to 1.7)	1.5 (1.1 to 2.1)*
Religious minorities	285	38 (17.5)	2.9 (1.7 to 5.0)***	2.4 (1.2 to 4.7)*
Relatively advantaged janajatis	1884	210 (11.9)	1.9 (1.4 to 2.5)***	1.2 (0.9 to 1.6)
Upper caste groups	3919	290 (7.8)	1.2 (0.9 to 1.5)	1.0 (0.7 to 1.3)
Education				
Illiterate/no formal schooling	6128	535 (8.4)	1	1
Below secondary (<10 years)	2548	196 (7.9)	1.0 (0.8 to 1.2)	1.1 (0.8 to 1.4)
Secondary and above (≥10 years)	2601	274 (10.1)	1.3 (1.1 to 1.6)**	1.4 (1.1 to 1.8)*
Province				
Karnali province	565	16 (3.2)	1	1
Province 1	1909	134 (7.7)	2.5 (1.2 to 5.2)*	2.2 (1.1 to 4.4)*
Province 2	1845	138 (8.5)	2.8 (1.3 to 5.8)**	1.8 (0.9 to 3.7)
Bagmati province	2820	298 (11.5)	3.9 (1.9 to 8.0)***	1.8 (0.9 to 3.5)
Gandaki province	1249	79 (6.7)	2.2 (1.0 to 4.6)*	1.1 (0.6 to 2.3)
Lumbini	1905	170 (9.6)	3.2 (1.5 to 6.6)**	1.9 (0.9 to 3.8)
Sudurpaschim province	984	49 (5.2)	1.6 (0.7 to 3.8)	1.5 (0.7 to 3.5)
Place of residence				
Rural	5663	277 (5.5)	1	1
Urban	5614	607 (11.3)	2.2 (1.8 to 2.7)***	1.7 (1.4 to 2.2)***

*P<0.05, **p<0.01, ***p<0.001.
AOR, adjusted OR; COR, crude OR.

change in dietary pattern, sedentary lifestyle, reduction in physical activity might have contributed to the higher burden of DM. Complementing this result, findings from NCDs STEPS survey 2019 suggests inadequate intake of fruits and vegetables and lower participation in physical activity among urban population compared with their rural counterparts.[38] All these factors might have some contributing role towards higher prevalence of DM among urban population. Similar to the findings from this study, an epidemiological survey conducted by the Nepal Diabetes Association found higher prevalence (14.6%) of DM in urban area in comparison to rural area (2.5%).[39 40] Consistent with the findings from our study, a systematic review also found the pooled prevalence of DM to be higher (8.1%, 95% CI 7.3% to 8.9%) in urban areas compared with rural areas in Nepal (1.03%, 95% CI 0.7% to 1.3%).[8] A study from Myanmar also presented similar findings of higher prevalence in urban areas compared with rural areas (12.1% vs 7.1%).[41] Studies have reported between two and five times higher odds of having DM and pre-DM in association with urban residence.[42 43]

Our study showed that participants with raised blood pressure had about two times higher odds of having DM compared with those whose blood pressure was normal. This result is consistent with findings from South Asia,[34] Ethiopia[44] and Nepal.[8] The prevalence of hypertension and DM has been increasing in Nepal, however, the progress towards its effective prevention, treatment and control is found to be low.[9 45] With the coexisting conditions of hypertension and DM, the importance of

Table 4 Association of behavioural and biological factors with diabetes mellitus (DM)

Characteristics	No of participants	Proportion with DM, n (%)	Odds of having DM	
			COR (95% CI)	AOR (95% CI)
Smoking habit				
Non-smoker	7789	581 (8.0)	1	1
Smokers	3488	303 (9.5)	1.2 (1.0 to 1.4)*	1.0 (0.9 to 1.3)
Users of smokeless tobacco products				
Non-users	8544	642 (8.1)	1	–
Users	2733	242 (9.7)	1.2 (1.0 to 1.5)*	–
Users of either smoke or smokeless tobacco products				
Nonusers	9857	751 (8.3)	1	–
Users	1420	133 (10.1)	1.2 (1.0 to 1.5)	–
Alcohol consumption				
No	8538	657 (8.4)	1	–
Yes	2739	227 (8.7)	1.0 (0.9 to 1.2)	–
Blood pressure				
Normal	7197	311 (4.6)	1	1
Raised	4080	573 (15.1)	3.7 (3.1 to 4.4)***	2.2 (1.8 to 2.7)***
Body mass index (N=12 556)				
Normal	6378	355 (6.1)	1	1
Underweight	1365	51 (4.0)	0.6 (0.4 to 0.9)*	0.8 (0.5 to 1.1)
Overweight and obese	3534	478 (14.6)	2.6 (2.2 to 3.1)***	2.0 (1.6 to 2.4)***
Increased waist hip ratio (N=11 158)				
No	4683	347 (8.0)	1	–
Yes	6475	527 (8.9)	1.1 (0.9 to 1.4)	–
Total cholesterol (N=10 837)				
Normal	7722	478 (7.0)	1	1
Raised	3115	357 (11.8)	1.8 (1.5 to 2.1)***	1.0 (0.8 to 1.2)
Triglyceride (N=10 960)				
Normal	7103	334 (5.0)	1	1
Raised	3857	479 (13.4)	2.9 (2.5 to 3.5)***	2.1 (1.8 to 2.6)***

*P<0.05, ***p<0.001.
AOR, adjusted OR; COR, crude OR.

secondary prevention (screening, timely diagnosis and treatment) of both these conditions is of paramount importance.

Overweight and obesity are important risk factors for DM.[5 44 46] Our study showed that participants who were overweight and obese had about two times higher odds of having DM than those with a normal BMI. Consistent with the findings from our study, a meta-analysis performed among Indian adults showed a statistically significant association between obesity and type 2 DM (OR 1.14, 95% CI 1.0 to 1.2).[47] Similar findings were observed in different studies conducted in South Asia,[34] USA,[48] Ethiopia[44] and Nepal.[49] Overweight and obesity has been increasing in Nepal particularly among women.[50] Obesity being a strong predictor for DM, there is a need to take preventive actions to control obesity which might in turn provide some level of control of growing DM prevalence in the country.

The other variable that showed significant association with the prevalence of DM was triglyceride level. Participants with a high triglyceride level (≥150 mg/dL) had about two times higher odds of having DM than their counterparts. This is in line with findings from studies conducted elsewhere, including in Ethiopia,[44] Bangladesh[51] and China.[52] Similar findings have been reported by different previous studies from Nepal.[53–55] This also highlights the need of interventions for prevention and control of several of these metabolic risk factors such as dyslipidaemia so as to achieve DM control in Nepal.

Besides the factors explained above, the provincial differences in prevalence of DM (though not seen as statistically significant after multivariate analysis) also

highlights the importance of tailoring interventions to the provinces with higher prevalence such as province 1, 2, 5 and Bagmati province.

Our study has several strengths and limitations. Major strengths include: a large sample size, coverage of rural and urban residences; all three ecological belts of the country (the Terai, hills and mountains); and all provinces of Nepal. This approach provided nationally representative data and increased its generalisability among the Nepalese population. The study also provided detailed information on the possible association with a wide range of risk factors for DM. However, the cross-sectional nature of the study did not allow for a causal relationship to be established between these risk factors and the prevalence of DM. In addition, no information was collected on the physical activity and dietary habits of participants, which have been established as important predictors of DM in other studies.[56–59]

CONCLUSIONS

Our study showed DM to be more prevalent among individuals aged 20 years and above. Older age, male gender, residing in urban areas, high BMI, raised blood pressure and raised triglyceride level independently predicted the occurrence of DM in this study. Findings suggest that targeted DM prevention and control interventions, especially to those population groups with higher chances of DM occurrence, in addition to prevention and control of the biological risk factors associated with DM through appropriate measures, would help curb the prevalence of DM in Nepal.

Correction notice This article has been corrected since it was first published. One of the author's name has been updated.

Twitter Krishna Kumar Aryal @Kriessh

Acknowledgements The authors would like to acknowledge all the study participants and field enumerators for their invaluable support. We further acknowledge the Steering Committee members and the Technical Working Group members who guided the study. We sincerely acknowledge the support of Matilda Nash from Abt Britain in reviewing and copyediting the manuscript.

Contributors NS is the guaranter for this study. KK, KKA and MD conceived the study. NG and DKC helped in data entry and management. KKA and NS was involved in conducting data analysis. NS, KKA, AP and NKM wrote the manuscript. PG and AKJ supported in monitoring overall data quality. All authors reviewed the manuscript. NS and KK contributed equally.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Consent obtained directly from patient(s)

Ethics approval The study was approved by the Ethical Review Board of Nepal Health Research Council under registration number: 110/2016. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data will be available on request.

ORCID iDs
Namuna Shrestha http://orcid.org/0000-0003-2697-5976
Anil Poudyal http://orcid.org/0000-0003-2687-2993
Dirghayu KC http://orcid.org/0000-0002-6184-0615
Meghnath Dhimal http://orcid.org/0000-0001-7176-7821

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