



# Assessment of Risk of Type 2 Diabetes Among Adults of Banepa Municipality, Nepal: Community Based Cross-Sectional Study



Sailendra Thapa<sup>1\*</sup>, Pratigya Kayastha<sup>1</sup>, Durga Khadka Mishra<sup>1</sup>

<sup>1</sup>Department of Public Health, Manmohan Memorial Institute of Health Sciences, Kathmandu, Nepal

**Corresponding Author:** Sailendra Thapa, Department of Public Health, Manmohan Memorial Institute of Health Sciences, Kathmandu, Nepal. Tel: +977-9841040514, Email: [thapasailen@gmail.com](mailto:thapasailen@gmail.com)

Received August 24, 2019; Accepted January 30, 2020; Online Published March 9, 2020

## Abstract

**Introduction:** The prevalence of type 2 diabetes has been escalating worldwide, including low- and middle-income countries such as Nepal. Early detection of individuals at risk is of the utmost importance to prevent the escalating condition. This study used a simple, cost-effective screening tool known as the Indian Diabetes Risk Score (IDRS) in order to assess the proportion of risk groups and factors associated with it among the residents of Banepa municipality, a semi-urban area of central Nepal.

**Methods:** A community-based cross-sectional study was conducted among 245 adults of Banepa municipality. Face to face interviews were conducted to collect the information through a pretested, semi-structured questionnaire. IDRS was used to identify the risk group for developing type 2 diabetes. Data were entered in Microsoft Excel 2010 and exported to SPSS v.11.5 for further analysis.

**Results:** The proportion of people with high risk, moderate risk and low risk was 31%, 51.4% and 17.6%, respectively for developing type 2 diabetes. The analysis showed age ( $P < 0.01$ ), education ( $P = 0.05$ ), marital status ( $P = 0.01$ ), body mass index (BMI) ( $P < 0.01$ ), waist circumference ( $P < 0.01$ ), physical activities ( $P < 0.01$ ) and family history of diabetes ( $P < 0.04$ ) were significantly associated with risk of type 2 diabetes.

**Conclusion:** Nearly one-third of the study participants were in high-risk group and half of them were at moderate risk. This increasing trend of risk requires an urgent application of preventive measures through lifestyle modification.

**Keywords:** Indian Diabetes Risk Score, Type 2 Diabetes Mellitus, Nepal

**Citation:** Thapa S, Kayastha P, Mishra DK. Assessment of risk of type 2 diabetes among adults of banepa municipality, Nepal: community based cross-sectional study. Int J Travel Med Glob Health. 2020;8(1):31-36. doi:[10.34172/ijtmgh.2020.05](https://doi.org/10.34172/ijtmgh.2020.05).

## Introduction

Diabetes is a chronic metabolic disorder characterized by elevated levels of blood sugar, which leads over time to serious damage to the heart, blood vessels, eyes, kidneys, and nerves. Type 2 diabetes mellitus (T2DM) is the most common form of diabetes among adults. The increase in the burden of this disease has been proposed due to two major factors, namely epidemiological and nutritional transition.<sup>1</sup> The prevalence of T2DM has been escalating worldwide, including low and middle-income countries such as Nepal. According to World Health Organization (WHO), 422 million people were living with T2DM in 2014 and it is estimated to 642 million by the year 2035.<sup>2</sup> The increasing prevalence of this disease indicates the increasing prevalence of undiagnosed T2DM in community.<sup>3</sup> It is estimated that around 183 million people are living with undiagnosed diabetes.<sup>4</sup> A recent study conducted in a semi-urban area of Nepal shows 11.2% prevalence of

T2DM.<sup>5</sup> T2DM is no longer considered as the disease of affluence as people from semi-urban and rural areas are also at higher risk.<sup>6,7</sup>

The Indian Diabetes Risk Score (IDRS) was developed by Madras Diabetes Research Foundation, Chennai and is considered as the strongest predictor of the risk of diabetes.<sup>8</sup> It is a risk score-based with two modifiable risk factors (waist circumference and physical inactivity) and two non-modifiable risk factors (age and family history of diabetes) and widely considered as a cost-effective tool for the detection of undiagnosed people in a community. Applying this tool in a community-based screening program might be helpful for resource-poor settings. The advantage of IDRS is its simplicity, low cost and an easy application in mass screening programs.<sup>9</sup>

Community-based screening for diabetes helps to differentiate asymptomatic individuals who are at high risk of diabetes from individuals at lower risk, so that appropriate

preventive strategies can be initiated early. T2DM has been considered as irreversible, however, studies show reversal stage can be achieved through weight loss and low calorie diet.<sup>10-12</sup> Furthermore, the condition can be easily achieved if detected at an early stage. Early detection of risk group people helps to prevent disease progression through cost-effective methods of lifestyle intervention. Managing T2DM through lifestyle intervention is more cost-effective<sup>13</sup> than using medication.<sup>14,15</sup> Early detection of risk individuals is of utmost importance to prevent the escalating condition of T2DM in Nepal. In this context, this study assessed the proportion of risk groups and revealed the factors associated with it.

## Methods

Community-based cross-sectional study was conducted in Banepa municipality, a semi-urban area located about 25 kilometers away from the capital city of Nepal. Adults above 20 years were included whereas adults diagnosed with diabetes and pregnant women were excluded from the study. Sample size was calculated by using formula,  $n = Z^2 p (1-q) / d^2$ , where,  $p = 17.7\%$  (0.177) and  $q = 1 - p$  (1-0.177),  $= 0.823$  and  $d = 0.05$ . The value of 'p' was considered as the prevalence of overweight which is taken from the STEPS survey of Nepal.<sup>16</sup> Hence, the final sample size with a 10% non-response rate was 245. There are 14 wards in Banepa municipality. Four wards were randomly selected through the lottery method. Then Proportionate probability random sampling was performed. The number of study participants selected from wards 5, 7, 8, and 9 was 56, 52, 76, and 61, respectively. The first household from each ward was selected by bottle spinning from the ward office of the respective ward. Then, the sample was collected from the household towards the direction of the tip of the bottle until we reached the required sample. During the data collection, if there were more than one eligible person then, in that case, we conducted a lottery method to select a single candidate, so that we can include a more diverse population. All this process was repeated in all wards during data collection.

Face to face interview was conducted to collect data. Pretested, semi-structured questionnaire was used to assess the socio-demographic, behavioural and biological characteristics of the participants. Anthropometric measurement was done to measure height, weight, waist circumference and to calculate body mass index (BMI). Height was measured in meter and weight was measured in kilograms. The risk group was categorized according to IDRS.<sup>8</sup> Thus, the prepared questionnaire was translated into the native language (Nepali). All the anthropometric measurement tools and the questionnaires (translated) were pretested among 30 people of Khokana municipality of Lalitpur district. The collected data were coded and entered in Micro-soft excel 2010 and exported to Statistical Package for Social Science (SPSS v.11.5) for analysis. Data are presented as frequency, percentage, mean, and standard deviation. Chi-square test (at 5% level of significance and 95% CI) was done to see the association between the risk of T2DM and individual risk factors. Institutional Review Committee (IRC) of Manmohan Memorial Institute of Health Sciences

(MMIHS), Kathmandu, Nepal provided the ethical clearance. Data were collected after obtaining written informed consent from each participant. The objective of the study was clearly explained prior to collecting the data.

## Results

The socio-demographic characteristics are shown in Table 1. The mean age was  $42.57 \pm 12.3$  years with a majority (66.1%) of male participants. Most (72.2%) of the participants belong to Janajati. More than half (55.1%) of them were involved in small or large scale businesses as a part of their occupation. One-fourth of the respondents were smokers among them the majority (43.1%) used to smoke 1-5 cigarettes each day. More than half (59.2%) used to drink alcohol and most (65%) used to drink sealed pack alcohol.

The risk group for developing T2DM was classified by using IDRS and shown in Table 2. Almost half (51.4%) of the participants were at moderate risk followed by high-risk groups (31%) for developing T2DM. And few (17.6%) were at a lower risk.

Factors associated with the risk of developing T2DM are displayed in Table 3. Age ( $P < 0.01$ ), education ( $P = 0.05$ ), marital status ( $P = 0.01$ ), BMI ( $P < 0.01$ ), waist circumference ( $P < 0.01$ ), physical activity ( $P < 0.01$ ) and family history of diabetes ( $P = 0.04$ ) were found to be associated with the risk of T2DM.

## Discussion

This study employed IDRS to identify the risk status of respondents for developing T2DM and assessed the factors associated with it. This study found a 31% prevalence of high-risk groups among the participants of Banepa municipality. Similar findings by using the IDRS score were obtained by the study conducted in India.<sup>3,17</sup> However, another cross-sectional study contradicted these results and found a 14.9% prevalence of risk group.<sup>4</sup> The fluctuation in results might be due to differences in participants, who had different lifestyles and social contexts such as rapid urbanization. The present study was conducted in the newly emerging business hub. Similarly, the prevalence of moderate-risk and low-risk groups were 51.4% and 17.6%, respectively. Half of the participants were at moderate risk, to which we can predict that if the condition remains the same, then these people will be the potential candidates for the high-risk group. Higher prevalence (67.7%) of moderate-risk group was shown by Arun et al.<sup>4</sup> Whereas Gupta et al found similar results with 50.3% of participants at moderate risk and 18.5% at low risk for T2DM.<sup>17</sup> Both of these studies had the highest number of participants of age group 35-49, similar to this study.

The analysis showed a strong association between age and risk of T2DM and the risk increases with age. Positive association of age with diabetes was shown by different studies in Nepal.<sup>18-20</sup> Increasing life expectancy in addition to increasing obesity and a sedentary lifestyle might lead to a higher risk of T2DM. Likewise, this study found as educational level increases, the risk of having disease also increases. Higher education is usually linked with more table work leading to less physical activity which makes them

**Table 1.** Demographic characteristics of the respondents (n = 245)

Variables	No.	Percent
<b>Age</b>		
Mean $\pm$ SD	42.57 $\pm$ 12.3	
<b>Sex</b>		
Male	162	66.1
Female	83	33.9
<b>Ethnicity</b>		
Brahmin	44	18.0
Chhetri	23	9.4
Janajati	177	72.2
Dalit	1	0.4
<b>Marital status</b>		
Unmarried	30	12.2
Married	215	87.8
<b>Family type</b>		
Nuclear	118	48.2
Joint	127	51.8
<b>Educational status</b>		
Illiterate	17	6.9
Literate	17	6.9
Primary	25	10.2
Secondary	146	59.6
University education	40	16.3
<b>Employment status</b>		
Unemployed	7	2.9
Business	135	55.1
Service	25	10.2
Housemakers	30	12.2
Students	3	1.2
Agriculture	45	18.4
<b>Socio-economic status</b>		
Below poverty line	16	6.5
Above the poverty line	229	93.5
<b>Smoking status</b>		
No	187	76.3
Regularly	38	15.5
Occasionally	20	8.2
<b>No. of cigarettes per day</b>		
1-5	25	43.1
6-10	16	27.6
11-15	4	6.9
>15	13	22.4
<b>Alcohol consumption</b>		
No	145	59.2
Regularly	9	3.7
Occasionally	91	37.1
<b>Type of alcohol</b>		
Sealed pack	65	65
Home made	35	35
<b>Salt consumption</b>		
More than 5 g	163	66.5
Less than 5 g	82	33.5
<b>BMI score of the respondent</b>		
Underweight	2	0.8
Normal weight	144	58.8
Overweight	83	33.9
Obese	16	6.5

**Table 2.** Indian Diabetes Risk Score (IDRS) of the respondents (n=245)

Variables	No.	Percent
<b>Age</b>		
<35	73	29.8
35-49	108	44.1
$\geq$ 50 years	64	26.1
<b>Waist circumference</b>		
Waist <80 cm (female), <90 cm (male)	111	45.3
Waist $\geq$ 80-89 cm (female), $\geq$ 90-99 cm (male)	78	31.8
Waist $\geq$ 90 cm (female), $\geq$ 100 cm (male)	56	22.9
<b>Physical activity</b>		
Regular vigorous exercise or strenuous (manual) activities at home/work	22	9
Regular moderate exercise or moderate physical activity at home/work	84	34.3
Regular mild exercise or mild physical activity at home/work	90	36.7
No exercise and/or sedentary activities at home/work	49	20.0
<b>Family history of diabetes</b>		
No diabetes in parents	181	73.9
One parent is diabetic	55	22.4
Both parents are diabetic	9	3.7
<b>Classification of risk of participants</b>		
Low-risk groups (<30)	43	17.6
Moderate risk groups (30-60)	126	51.4
High-risk groups ( $\geq$ 60)	76	31.0

susceptible to T2DM, as business was the occupation of the majority of the participants of this study. In contrast with this result, other studies showed an inverse relationship between educational level and T2DM.<sup>21,22</sup> A strong association was observed between marital status and the risk of diabetes by this study. This result was contradicted by the studies conducted in Iran.<sup>21,23,24</sup> BMI was highly associated with the risk of T2DM. The relation between BMI and risk of diabetes was demonstrated by Vaidya et al,<sup>25</sup> Pandya et al<sup>26</sup> and Gupta et al.<sup>17</sup> Both insulin resistance and defective insulin secretion are most often seen among obese people, leading toward the occurrence of diabetes. The relation between diabetes and obesity is so strong, the term 'diabesity' has been introduced.<sup>27</sup> Similarly, this study found a relation between waist circumference and risk of T2DM. By increasing waist circumference, obesity also increases and this relationship is supported by Pandya et al<sup>26</sup> and Patil et al.<sup>3</sup> Our study found a strong association between physical activity and risk of T2DM. Those living a sedentary lifestyle are at higher risk. A study from Iran found a decreased risk of T2DM among non-obese and those having enough exercise.<sup>28</sup> Increased physical activity helps to lose weight which results in decreasing the risk of T2DM. Association was found between family history of T2DM with risk status and the relation was supported by different studies.<sup>29-31</sup> however, this finding is in contrast with that of the study conducted in India.<sup>3</sup> Given that culture for screening for T2DM in Nepal has been developed in recent years only, the study participants might not be aware of the status of the disease of their parents. Similarly, a relation between a sedentary lifestyle and the risk of diabetes has been demonstrated by different studies.<sup>32,33</sup> This result suggests that

**Table 3.** Association Between Risk Factors and Risk of Type 2 Diabetes

Variables	Classification of Risk Status			P Value
	Low Risk (IDRS <30), n=43 (17.6%)	Moderate Risk (IDRS 30 to <60), n=126 (51.4%)	High Risk (IDRS ≥ 60), n=76 (31.0%)	
<b>Age</b>				
<35	36 (49.3%)	34 (46.6%)	3 (4.1%)	<0.01*
35-49	4 (3.7%)	63 (58.3%)	41 (38.0%)	
≥50	2 (3.1%)	30 (46.9%)	32 (50.0%)	
<b>Sex</b>				
Male	27 (16.7%)	84 (51.9%)	51 (31.5%)	0.95
Female	15 (18.1%)	43 (51.8%)	25 (30.15)	
<b>Education</b>				
Illiterate	1 (5.9%)	4 (23.5%)	12 (70.6%)	0.05*
Literate	1 (5.9%)	11 (64.7%)	5 (29.4%)	
Primary	3 (12.0%)	11 (44.0%)	11 (44.0%)	
Secondary	26 (17.8%)	79 (54.1%)	41 (28.1%)	
University education	11 (27.5%)	22 (55.0%)	7 (17.5%)	
<b>Marital status</b>				
Unmarried	12 (40.0%)	14 (46.7%)	4 (13.3%)	0.01*
Married	30 (14.0%)	113 (52.6%)	72 (33.5%)	
<b>Family type</b>				
Nuclear	20 (16.9%)	61 (51.7%)	37 (31.4%)	0.99
Joint	22 (17.3%)	66 (52.0%)	39 (30.7%)	
<b>Employment status</b>				
Unemployed	0 (0.0%)	4 (57.1%)	3 (42.9%)	0.22
Business	20 (14.8%)	66 (48.9%)	49 (36.3%)	
Service	7 (28.0%)	16 (64.0%)	2 (8.0%)	
House makers	5 (16.7%)	14 (46.7%)	11 (36.7%)	
Students	1 (33.1%)	2 (66.7%)	0 (0.0%)	
Agriculture	9 (20.0%)	25 (55.6%)	11 (24.4%)	
<b>Socio-economic status</b>				
Below poverty line	1 (6.3%)	12 (75.0%)	3 (18.8%)	0.15
Above poverty line	41 (17.9%)	115 (50.2%)	73 (31.9%)	
<b>Smoking status</b>				
No	38 (20.3%)	94 (50.3%)	55 (29.4%)	0.17
Regularly	2 (5.3%)	23 (60.5%)	13 (34.2%)	
Occasionally	2 (10.0%)	10 (50.0%)	8 (40.0%)	
<b>Alcohol consumption</b>				
No	31 (21.4%)	73 (50.3%)	41 (28.3%)	0.13
Regularly	0 (0.0%)	4 (44.4%)	5 (55.6%)	
Occasionally	11 (12.1%)	50 (54.9%)	30 (33.0%)	
<b>Salt consumption</b>				
More than 5 g	30 (18.4%)	81 (49.7%)	52 (31.9%)	0.60
Less than 5 g	12 (14.6%)	46 (56.1%)	24 (29.3%)	
<b>BMI</b>				
Underweight	1 (50.0%)	1 (50.0%)	0 (0.0%)	<0.01*
Normal weight	39 (27.1%)	85 (59.0%)	20 (13.9%)	
Overweight	2 (2.4%)	40 (48.2%)	41 (49.4%)	
Obese	0 (0.0%)	1 (6.3%)	15 (93.8%)	
<b>Waist circumference</b>				
Waist <80 cm (female), <90 cm (male)	38 (34.2%)	65 (58.6%)	8 (7.2%)	<0.01*
Waist ≥80-89 cm (female), ≥90-99 cm (male)	4 (5.1%)	44 (56.4%)	30 (38.5%)	
Waist ≥90 cm (female), ≥100 cm (male)	0 (0.0%)	18 (32.1%)	38 (67.9%)	
<b>Physical activity</b>				
Regular vigorous exercise	10 (45.5%)	10 (45.5%)	2 (9.1%)	<0.01*
Regular moderate exercise	13 (15.5%)	56 (66.7%)	15 (17.9%)	
Regular mild exercise	18 (20.0%)	42 (46.7%)	30 (33.3%)	
No exercise/sedentary activities	1 (2.0%)	19 (38.8%)	29 (59.2%)	
<b>Family history of diabetes</b>				
No diabetes in parents	38 (21.0%)	97 (53.6%)	46 (25.4%)	0.04*
One parent is diabetic	4 (7.3%)	27 (49.1%)	24 (43.6%)	
Both parents are diabetic	0 (0.0%)	3 (33.3%)	6 (66.7%)	



doing physical activities is one of the important measures to prevent T2DM. Lower physical activity leads towards obesity, which in turn can develop T2DM. Mechanization in agricultural sector, as Nepal is an agricultural country, might have reduced physical activity.

As this is a cross-sectional study, the association between exposure and outcome variables might not be causation. Blood glucose tests among high-risk group people could not be done due to a lack of financial support. This study is perhaps the first conducted in Nepal by using IDRS in order to identify the risk of T2DM. The components of IDRS (age, family history of diabetes, waist circumference, and physical activity) are well-known risk factors for causing T2DM. A large-scale study by using this kind of tool is recommended in a community setting for early detection of risk groups so that future complications and burden of disease can be minimized.

### Conclusion

This study used IDRS to identify the risk group for T2DM. Nearly one-third of the study participants were at high risk. Increasing age and waist circumference and being obese found to be significantly associated with the risk of T2DM. A sedentary lifestyle further affects the risk of disease. Hence, IDRS being a cost-effective tool for screening T2DM is recommended for routine screening at the community level. Early detection of risk groups might help for the application of preventive measures so that further complications can be minimized.

### Authors' Contributions

ST and PK conceived the study design, coordinated for acquisition, analysis, and interpretation of the data. ST drafted the manuscript and PK and DKM critically revised the manuscript. All authors read and approved the final version.

### Conflict of Interest Disclosures

The authors declare that they have no competing interests.

### Ethics Approval

The Institutional Review Committee, Manmohan Memorial Institute of Health Sciences, Kathmandu, Nepal reviewed and approved the study. Written informed consent was obtained from all the participants after explaining the objective of the study.

### Funding/Support

This study has not been supported financially by any person or organization.

### Acknowledgements

We would like to acknowledge all the participants of this study and express gratitude to all the faculties of the Department of Public Health, Manmohan Memorial Institute of Health Sciences. We are also grateful to Dr. Viswanathan Mohan, and IDRS.

### References

1. Drewnowski A, Popkin BM. The nutrition transition: new

### Research Highlights

#### What Is Already Known?

Prevalence and risk of type 2 diabetes among people of urban areas were already known.

#### What This Study Adds?

By changing patterns of food intake, physical activity, and lifestyle people of the semi-urban area are also at higher risk of developing type 2 diabetes. An immediate preventive and promotive actions need to be taken in order to address the emerging health problem in low resource settings.

- trends in the global diet. *Nutr Rev.* 1997;55(2):31-43. doi:[10.1111/j.1753-4887.1997.tb01593.x](https://doi.org/10.1111/j.1753-4887.1997.tb01593.x).
- World Health Organization (WHO). *Global Report on Diabetes*. Geneva: WHO; 2016.
  - Patil RS, Gothankar JS. Assessment of risk of type 2 diabetes using the Indian Diabetes Risk Score in an urban slum of Pune, Maharashtra, India: a cross-sectional study. *WHO South East Asia J Public Health.* 2016;5(1):53-61. doi:[10.4103/2224-3151.206555](https://doi.org/10.4103/2224-3151.206555).
  - Arun A, Srivastava JP, Gupta P, Sachan B, Prakash D, Zaidi ZH. Indian diabetes risk score (IDRS), a strong predictor of diabetes mellitus: a cross sectional study among urban and rural population of Lucknow. *Int J Appl Res.* 2015;1(7):135-138.
  - Gyawali B, Hansen MRH, Povlsen MB, et al. Awareness, prevalence, treatment, and control of type 2 diabetes in a semi-urban area of Nepal: findings from a cross-sectional study conducted as a part of COBIN-D trial. *PLoS One.* 2018;13(11):e0206491. doi:[10.1371/journal.pone.0206491](https://doi.org/10.1371/journal.pone.0206491).
  - Thapa S, Pyakurel P, Baral DD, Jha N. Health-related quality of life among people living with type 2 diabetes: a community based cross-sectional study in rural Nepal. *BMC Public Health.* 2019;19(1):1171. doi:[10.1186/s12889-019-7506-6](https://doi.org/10.1186/s12889-019-7506-6).
  - Thapa S, Jha N, Baral D, Pyakurel P. Health care seeking behaviour among people living with type-2 diabetes in rural area of eastern, Nepal. *International Journal of Public Health & Safety.* 2018;3(3):166.
  - Mohan V, Deepa R, Deepa M, Somannavar S, Datta M. A simplified Indian Diabetes Risk Score for screening for undiagnosed diabetic subjects. *J Assoc Physicians India.* 2005;53:759-763.
  - Joshi SR. Indian diabetes risk score. *J Assoc Physicians India.* 2005;53:755-757.
  - Davies MJ, D'Alessio DA, Fradkin J, et al. Management of hyperglycaemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetologia.* 2018;61(12):2461-2498. doi:[10.1007/s00125-018-4729-5](https://doi.org/10.1007/s00125-018-4729-5).
  - Hallberg SJ, Gershuni VM, Hazbun TL, Athinarayanan SJ. Reversing type 2 diabetes: a narrative review of the evidence. *Nutrients.* 2019;11(4). doi:[10.3390/nu11040766](https://doi.org/10.3390/nu11040766).
  - Karter AJ, Nundy S, Parker MM, Moffet HH, Huang ES. Incidence of remission in adults with type 2 diabetes: the diabetes & aging study. *Diabetes Care.* 2014;37(12):3188-3195. doi:[10.2337/dc14-0874](https://doi.org/10.2337/dc14-0874).
  - Pan XR, Li GW, Hu YH, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. *Diabetes Care.* 1997;20(4):537-544. doi:[10.2337/diacare.20.4.537](https://doi.org/10.2337/diacare.20.4.537).
  - Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med.* 2002;346(6):393-403. doi:[10.1056/NEJMoa012512](https://doi.org/10.1056/NEJMoa012512).
  - Tuomilehto J, Lindström J, Eriksson JG, et al. Prevention of type

- 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med.* 2001;344(18):1343-1350. doi:[10.1056/nejm200105033441801](https://doi.org/10.1056/nejm200105033441801).
16. Aryal KK. Non Communicable Diseases Risk Factors: STEPS Survey Nepal 2013. Kathmandu, Nepal: Nepal Health Research Council (NHRC); 2014.
  17. Gupta SK, Singh Z, Purty AJ, Vishwanathan M. Diabetes prevalence and its risk factors in urban Pondicherry. *Int J Diabetes Dev Ctries.* 2009;29(4):166-169. doi:[10.4103/0973-3930.57348](https://doi.org/10.4103/0973-3930.57348).
  18. Chhetri MR, Chapman RS. Prevalence and determinants of diabetes among the elderly population in the Kathmandu Valley of Nepal. *Nepal Med Coll J.* 2009;11(1):34-38.
  19. Joshi HS, Mahmood SE, Joshi MC, Shaifali I. Obesity indices among t diabetics in an urban population of Western Nepal. *J Diabetes Metab.* 2011;2(5):134. doi:[10.4172/2155-6156.1000134](https://doi.org/10.4172/2155-6156.1000134).
  20. Mehta KD, Karki P, Lamsal M, et al. Hyperglycemia, glucose intolerance, hypertension and socioeconomic position in eastern Nepal. *Southeast Asian J Trop Med Public Health.* 2011;42(1):197-207.
  21. Azimi-Nezhad M, Ghayour-Mobarhan M, Parizadeh MR, et al. Prevalence of type 2 diabetes mellitus in Iran and its relationship with gender, urbanisation, education, marital status and occupation. *Singapore Med J.* 2008;49(7):571-576.
  22. Hwang J, Shon C. Relationship between socioeconomic status and type 2 diabetes: results from Korea National Health and Nutrition Examination Survey (KNHANES) 2010-2012. *BMJ Open.* 2014;4(8):e005710. doi:[10.1136/bmjopen-2014-005710](https://doi.org/10.1136/bmjopen-2014-005710).
  23. Rahmanian K, Shojaei M, Sotoodeh Jahromi A. Relation of type 2 diabetes mellitus with gender, education, and marital status in an Iranian urban population. *Rep Biochem Mol Biol.* 2013;1(2):64-68.
  24. Ramezankhani A, Azizi F, Hadaegh F. Associations of marital status with diabetes, hypertension, cardiovascular disease and all-cause mortality: a long term follow-up study. *PLoS One.* 2019;14(4):e0215593. doi:[10.1371/journal.pone.0215593](https://doi.org/10.1371/journal.pone.0215593).
  25. Vaidya A, Shakya S, Krettek A. Obesity prevalence in Nepal: public health challenges in a low-income nation during an alarming worldwide trend. *Int J Environ Res Public Health.* 2010;7(6):2726-2744. doi:[10.3390/ijerph7062726](https://doi.org/10.3390/ijerph7062726).
  26. Pandya H, Lakhani JD, Patel N. Obesity is becoming synonym for diabetes in rural areas of India also an alarming situation. *Int J Biol Med Res.* 2011;2(2):556-560.
  27. Golay A, Ybarra J. Link between obesity and type 2 diabetes. *Best Pract Res Clin Endocrinol Metab.* 2005;19(4):649-663. doi:[10.1016/j.beem.2005.07.010](https://doi.org/10.1016/j.beem.2005.07.010).
  28. Ghaderpanahi M, Fakhrzadeh H, Sharifi F, et al. Association of physical activity with risk of type 2 diabetes. *Iran J Public Health.* 2011;40(1):86-93.
  29. Mohan V, Shanthirani CS, Deepa R. Glucose intolerance (diabetes and IGT) in a selected South Indian population with special reference to family history, obesity and lifestyle factors--the Chennai Urban Population Study (CUPS 14). *J Assoc Physicians India.* 2003;51:771-777.
  30. Ahmad J, Masoodi MA, Ashraf M, et al. Prevalence of diabetes mellitus and its associated risk factors in age group of 20 years and above in Kashmir, India. *Al Ameen J Med Sci.* 2011;4(1):38-44.
  31. Menon VU, Kumar KV, Gilchrist A, et al. Prevalence of known and undetected diabetes and associated risk factors in central Kerala--ADEPS. *Diabetes Res Clin Pract.* 2006;74(3):289-294. doi:[10.1016/j.diabres.2006.03.025](https://doi.org/10.1016/j.diabres.2006.03.025).
  32. Singh RB, Bajaj S, Niaz MA, Rastogi SS, Moshiri M. Prevalence of type 2 diabetes mellitus and risk of hypertension and coronary artery disease in rural and urban population with low rates of obesity. *Int J Cardiol.* 1998;66(1):65-72. doi:[10.1016/s0167-5273\(98\)00141-7](https://doi.org/10.1016/s0167-5273(98)00141-7).
  33. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. *Indian J Med Res.* 2007;125(3):217-230.