

Article

Prevalence of Diabetes Mellitus and Cardiovascular Risk Factors in El Trébol, Argentina: A Population-Based Cross-Sectional Study

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Abstract

Background and Objectives: The objectives of this study were to determine the prevalence of diabetes mellitus (DM) and major cardiometabolic comorbidities in adults living in El Trébol, Argentina, and to evaluate their associations using laboratory-confirmed, community-based data. **Methods:** A cross-sectional, probabilistic, two-phase design was implemented, combining a household survey with clinical and biochemical assessments. Of 1112 surveyed adults aged 20–79 years, 860 completed the clinical phase and formed the effective sample. Cardiometabolic risk factors, including obesity, hypertension, dyslipidemia, and physical inactivity, were assessed through standardized measurements and questionnaires. Multivariate logistic regression explored independent associations with DM. **Results:** Crude DM prevalence was 10.47%, higher in men and increasing markedly with age; the age-standardized prevalence for the Argentine population was 9.87%. Of all diabetes cases, 23% were previously undiagnosed. Obesity (35.62%), hypertension (38.83%), dyslipidemia, and physical inactivity (83.84%) were highly prevalent. DM was independently associated with older age, higher BMI, elevated triglycerides, lower HDL cholesterol, and insufficient physical activity. **Conclusions:** This study reveals a substantial cardiometabolic burden in a small urban Argentine population and suggests that self-report-based national surveys may misestimate true DM prevalence. Laboratory-confirmed, community-based surveillance is essential to strengthen early detection, guide targeted interventions, and inform equitable public health strategies.

Keywords: diabetes mellitus; prevalence; obesity; hypertension; dyslipidemia



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1. Introduction

The global prevalence of diabetes mellitus (DM) has been rapidly rising over the last decades, currently affecting an estimated 590 million people worldwide [1]. According

to the International Diabetes Federation, the global prevalence of diabetes continues to rise, driven by population aging, urbanization, increasing obesity, physical inactivity, and dietary transitions [2]. Type 2 DM (T2DM) frequently clusters with cardiometabolic comorbidities such as hypertension, dyslipidemia, and excess body weight, substantially increasing cardiovascular risk and healthcare costs [3]. In South and Central America, 35.4 million people are living with DM, with an estimated increase of 46% by 2050 [1]. In Argentina, a South American country with a population of 46 million inhabitants, the last Risk Factor's National Survey (4th ENFR), carried out in 2018, informed that the prevalence of self-reported elevated glucose levels or DM among the population aged 18 years and older was 12.7% (a significant increase from the previous data provided by 2013 ENFR, which was 9.8%) [4]. Even though this information is relevant for the country's health policies, the ENFR presents some important methodological limitations for estimating the prevalence of DM, including difficulty in distinguishing between reports of 'high blood glucose levels' and the actual presence of DM. Some other community-based studies have provided data on the prevalence of DM, following a multistage, systematic, and randomized methodology. A study carried out in the town of Venado Tuerto found an age- and sex-adjusted prevalence of 11.4% in 2017 [5]. Previous data from the same city informed an age- and sex-adjusted prevalence of 10.9% in 2010 and 7.7% in 1997 [5]. The prevalence data series obtained in Venado Tuerto is consistent with the growth projections estimated by the IDF. Older data obtained from the central region of the country show much lower prevalence rates than those recorded since the early years of the 21st century [6]. This escalating burden parallels the increasing prevalence of cardiovascular risk factors such as obesity, hypertension, dyslipidemia, and physical inactivity [7].

Age, sex, and geographic differences contribute to an heterogeneous distribution of the prevalence of the disease. The International Diabetes Federation reported that prevalence ranges from 1.9% among adults aged 20–24 years to nearly 25% among those aged 75–79, a proportion expected to increase further by 2050 [1]. Such findings emphasize the importance of evaluating diabetes through a multidimensional lens that includes age, sex, geography, and social determinants of health [6]. This also emphasizes the importance of community-based studies, which can contribute to a better interpretation of the data obtained through the ENFR.

DM frequently coexists with other metabolic and cardiovascular conditions, particularly arterial hypertension, dyslipidemia, and overweight/obesity. These comorbidities share overlapping pathophysiological mechanisms, such as insulin resistance, endothelial dysfunction, and chronic low-grade inflammation, which mutually reinforce each other, accelerate complications, and significantly worsen prognosis [8]. The three community-based studies carried out in Venado Tuerto confirmed the multivariate association of DM with age, Body Mass Index (BMI) and triglyceride levels [5]. The impact of the association between DM and various cardiovascular risk factors places a significant burden on public health, especially in low- and middle-income countries.

Considering the limitations of the ENFR and the need to update the latest data available in the literature, the importance of conducting new community-based studies becomes evident. These studies would enable the necessary adjustments in the estimation of the impact of the disease and its comorbidities in terms of public health.

The present study was designed to determine the prevalence of DM in the adult population of El Trébol City, Province of Santa Fe, Argentina, using a population-based, cross-sectional design with laboratory-confirmed diagnoses. Secondary objectives were to estimate the prevalence of major cardiometabolic comorbidities, including obesity, arterial hypertension, dyslipidemia, and physical inactivity, and to analyze their associations with DM. The novelty of this study lies in its two-phase community-based methodology, which

integrates household surveys with clinical and biochemical assessments, enabling the identification of undiagnosed cases and providing more accurate prevalence estimates than self-report-based national surveys.

2. Materials and Methods

This article was prepared in accordance with the STROBE guidelines for cross-sectional studies.

2.1. Setting and Participants

This study was conducted in the city of El Trébol, located in the west-central area of the province of Santa Fe, 187 km from the provincial capital (Santa Fe City). According to the 2022 National Census, the city has 12,422 inhabitants. Of this population, 53.91% are female. The age distribution shows that 41.70% of residents are between 20 and 39 years old; 36.50% are between 40 and 59 years old; and 21.80% are between 60 and 79 years old. It is an urban population with middle income levels relative to national values. Most of the population is of Caucasian origin.

This research was carried out in two phases:

(1) Household survey—conducted on a representative sample of the general population of El Trébol.

(2) Clinical and biochemical assessments—performed at a community center located in an easily accessible area of the city. The site was chosen to minimize losses due to transportation barriers and to facilitate attendance.

The household survey was selected using a probabilistic design, based on household units and individuals within selected households, using data from the 2022 Argentine National Census (see “Study design”). Individuals who completed both the household survey and the clinical/biochemical assessments were included in the prevalence analyses and constituted the “effective sample”. In total, 1112 individuals participated in the household surveys. Of these, 860 (77.34%) also completed clinical and biochemical assessments, thus forming the effective sample. Both phases were completed during the fourth quarter of 2024.

2.2. Study Design and Data Collection

A cross-sectional design was followed to estimate the prevalence of DM (primary outcome) and other associated comorbidities.

2.2.1. Inclusion and Exclusion Criteria

Inclusion criteria: men and women between 20 and 79 years old, permanent residents of El Trébol, and who provided written informed consent.

Exclusion criteria: individuals on corticosteroid treatment, institutionalized persons, pregnant women, or those unable to comprehend the survey questions.

2.2.2. Sampling and Intervention

The domiciliary phase final sample consisted of 1112 participants aged 20 to 79 years. This sample was representative of the respective population and based on a multistage probabilistic sampling design of household units. A city map, provided by the Town Hall planning division, categorized urban areas into four density levels: high, medium, low and very low/no density. Survey teams were assigned city blocks according to availability and transport access. A systematic approach was followed to maintain randomization. In each selected block, interviewers began at a designated corner (southeast, southwest, northeast, or northwest, depending on the block) and proceeded clockwise, interviewing the first house and then every third residence. If a household was unavailable, refused par-

ticipation, or was excluded, interviewers moved on to the next eligible house, continuing the pattern of interviewing every third house. Each household was surveyed only once, selecting a single individual (aged 20–79 years). If the required quotas were not met due to absences, one follow-up visit was permitted. The household survey was administered through face-to-face interviews by trained fieldworkers using a structured questionnaire (Supplementary File S1). The questionnaire consisted of 36 main items, with additional conditional sub-items, and included both sociodemographic and health-related variables. Collected information comprised biological sex, age, educational level, occupation, personal history of diabetes mellitus, age at diagnosis, current diabetes treatment, family history of diabetes and cardiovascular disease, history of arterial hypertension and dyslipidemia, cardiovascular events and interventions, smoking status, alcohol consumption, and physical activity.

Most questions were structured as single-choice categorical items, with predefined response options. Quantitative responses were collected for selected variables, including age at diagnosis, number of cigarettes per day, alcohol intake, anthropometric measurements, blood pressure values, and biochemical parameters. Conditional skip patterns were applied throughout the questionnaire to minimize respondent burden and ensure logical flow.

2.2.3. Phase 1: Household Survey

This primary phase (domiciliary survey) included a household survey carried out by approximately 30 trained interviewers. These teams were trained both in person and virtually on data collection methodology and participant selection. Interviewers first presented official identification and then explained this study to potential participants, inviting them to sign the informed consent form. The questionnaire collected demographic data, as well as personal and clinical history.

2.2.4. Phase 2: Clinical and Biochemical Assessment

The second phase took place at the Community Integration Center, equipped with medical consultation rooms and accessibility infrastructure. The center was organized into designated areas, including an entry desk, exit desk, waiting room, anthropometric measurement station, blood pressure assessment, and a blood collection area. Participants completed the evaluation process in approximately 30–35 min, guided throughout by staff. Appointments were scheduled between 8:00 and 10:00 am to ensure a 12 h fasting period before blood sampling. The effective sample ($n = 860$) included individuals who completed the household survey and attended this phase and underwent both physical and biochemical assessments. Prevalence determinations were measured on this effective sample, including height, weight and waist circumference (with participants barefoot and wearing light clothing). Of the participants with impaired fasting glucose (100–125 mg/dL), some did not undergo OGTT due to refusal, scheduling difficulties, or logistical constraints related to fasting requirements and availability.

2.3. Variables and Outcomes

Body Mass Index (BMI) was calculated as weight (kg)/height (m^2). Blood pressure was measured on the right arm, seated, using validated digital sphygmomanometers. A second and final measurement was taken after 5 min. Venous blood samples were drawn from the antecubital fossa. Analyses were performed at the local community center laboratory using a compact CM analyzer. These tests included fasting plasma glucose, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, and glycated hemoglobin (HbA1c). Biochemical assays were performed using enzymatic/colorimetric methods, while HbA1c was measured by immunoturbidimetry (TINA-QUANT TQ Gen 3—Roche).

Participants with fasting glucose between 100 and 125 mg/dL underwent standard Oral Glucose Tolerance Test (OGTT) following ADA-1997 and WHO-1999 criteria: ingestion of 75 g of anhydrous glucose dissolved in 375 mL of water within 5 min, with glucose measurements at 1 and 2 h.

Primary outcome: The primary outcome of this study was to assess the prevalence of DM, defined as follows:

- (1) Fasting plasma glucose ≥ 126 mg/dL;
- (2) 2 h plasma glucose ≥ 200 mg/dL (OGTT);
- (3) HbA1c $\geq 6.5\%$;
- (4) Self-reported diabetes with or without current treatment.

Secondary outcomes

Dyslipidemia: defined according to NCE-ATP III guidelines, which include all unmedicated individuals with a total cholesterol ≥ 200 mg/dL, triglycerides ≥ 150 mg/dL, HDL cholesterol < 40 mg/dL, LDL cholesterol ≥ 130 mg/dL, or current lipid-lowering therapy [8]. Proportion of patients with LDL < 100 mg/dL was also reported.

Hypertension: defined according to JNC 7 guidelines as blood pressure $\geq 140/90$ mmHg, or current antihypertensive therapy [9].

Obesity: BMI ≥ 30.0 kg/m²; overweight defined as BMI 25.0–29.9 kg/m²; normal weight as BMI 18.5–24.9 kg/m² [10].

Other factors:

This study also considered lifestyle factors listed as follows: smoking, defined in alignment with the WHO definition as daily tobacco use in the previous month; excessive alcohol consumption, characterized as a daily intake > 350 mL of beer/day, > 150 mL wine/day, or > 45 spirits/day; and insufficient physical activity, described as < 150 min/week of moderate aerobic activity.

2.4. Statistical Analysis

Sample size calculations: The effective sample size was estimated, assuming: (a) an expected DM prevalence of 12% (based on prior studies and the ENFR), (b) a 5% alpha error, and (c) an absolute precision of 2.5%. Based on these assumptions, the effective sample size was calculated to be 700 individuals. Anticipating a 35% loss between the household survey and the effective sample, the initial household survey sample size was estimated at 1100 individuals.

Analyses: Proportions are expressed as percentages; quantitative variables are expressed as mean values and their standard deviations. Ninety-five percent confidence intervals (95% CI) for proportions were calculated using the Clopper–Pearson method. The direct standardization method was applied for age adjustment by sex, enabling comparison with the Argentine population and the WHO reference population. Age was controlled for through age-standardized prevalence calculations, stratified analyses, and inclusion as a continuous covariate in multivariable logistic regression models. Calculating rates means dividing the number of health events by the size of the population. Crude rates look at the entire population, while specific rates examine particular groups. Adjusted rates account for factors such as age differences, making it easier to compare populations accurately.

Differences between two sets of quantitative data were assessed using Student's *t*-test. Univariate differences between groups of qualitative data were analyzed using the chi-squared test (Yates corrected) or Fisher's exact test, as appropriate. Univariate prevalence ratios were calculated to assess trends across age categories. The corresponding 95% confidence intervals were estimated using the Katz method. A chi-squared test for homogeneity between levels was performed, and a linear trend was also evaluated. A similar process was followed for obesity. Nonparametric correlations were obtained to

assess the associations between the presence of DM and other covariates such as obesity, hypertension, hypertriglyceridemia, and low HDL levels. Multivariate associations with DM were explored using a logistic regression model (maximum-likelihood, quasi-Newton), obtaining the correspondent odds ratios (OR) and their 95% confidence intervals. Distribution of quantitative variables was assessed prior to analysis. Given the large sample size and the approximately normal distribution observed for the main quantitative variables, the results are presented as means and standard deviations. p values below 0.05 (two tailed) were considered as statistically significant.

Phase 2 participation and assessment of potential non-responder bias: In population-based studies using a two-phase sampling design (home-based screening followed by clinical confirmation), there is an inherent risk that non-attenders differ systematically from attenders. We applied a set of statistical procedures to assess the potential misestimation of diabetes prevalence due to differential participation between Phase 2 attenders and non-attenders. These procedures included: (1) univariate comparisons of key characteristics between Phase 1 respondents and Phase 2 completers; (2) modeling the probability of Phase 2 completion using multiple logistic regression; and (3) calculating and applying inverse probability weighting (IPW) for prevalence adjustment (weights defined as $w_i = 1/p_{iwi} = 1/p_i$, whereby individuals less likely to attend receive higher weights). An excess of + 0.05% in prevalence after adjustment by application of weighted analysis was considered a relevant, and crude values for diabetes prevalence in the effective sample were used for standardization as well as for other statistical calculations.

2.5. Ethical Approval

This study complied with international ethical standards for epidemiological research. Written informed consent was obtained from all participants who were informed of this study's aims and procedures. Ethical approval was granted by the Independent Ethics Committee and the Biosafety Committee of the Faculty of Medical Sciences, National University of Rosario Argentina (CUDI: EXP-UNR No. 28970/2024). This study was done following the ethical principles outlined in the Declaration of Helsinki.

3. Results

3.1. Household Survey and Effective Sample

In the primary or household survey, 1112 individuals were interviewed, of whom 860 (77.34%) completed the secondary survey as they attended their appointments for clinical examinations and laboratory analyses. Prevalence data on DM and other risk factors were obtained from this effective sample. The mean age in the household sample was 45.39 ± 16.14 years, while in the effective sample, it was 45.47 ± 16.05 years ($p = 0.9237$) (Table 1). Females accounted for 53.87% of the household sample and 54.42% of the effective sample ($p = 0.8080$). The qualitative data recorded in Table 2 for participants in the effective sample showed no relevant differences compared to those obtained in the household survey. It is important to consider that in the household sample, 8.09% of participants self-reported having DM. This did not differ significantly from the proportion found in individuals who were part of the effective sample. Hereafter, the results obtained from the individuals comprising the effective sample are described below.

Table 1. General characteristics of the sample. Quantitative variables.

Variable	Total Effective Sample (N = 860) (Mean ± SD)	Women (N = 468) (Mean ± SD)	Male (N = 392) (Mean ± SD)	Women vs. Male <i>p</i> Value
Age (years)	45.5 ± 16.1	46.2 ± 16.3	44.6 ± 15.8	0.1573
BMI (kg/m ²)	28.9 ± 6.6	29.1 ± 7.3	28.5 ± 5.7	0.1766
Waist (cm)	91.9 ± 17.4	90.1 ± 18.0	94.2 ± 16.4	0.0006
Fasting glucose (mg/dL)	90.9 ± 26.4	88.7 ± 25.5	93.4 ± 27.2	0.0088
Hemoglobin A1c (%)	5.6 ± 1.0	5.6 ± 0.9	5.7 ± 1.1	0.0654
Total Cholesterolmia (mg/dL)	185 ± 40.9	187 ± 40.8	183 ± 41.1	0.01
LDL-c (mg/dL)	103.9 ± 30.3	103.7 ± 31.0	104.3 ± 29.4	0.0771
HDL-c (mg/dL)	51.7 ± 9.3	52.6 ± 9.8	50.6 ± 8.7	0.002
Triglyceridemia (mg/dL)	121 ± 100	111 ± 68.4	133 ± 127.5	0.001
Systolic Blood Pressure (mmHg)	128.1 ± 20.5	124.7 ± 20.8	132.2 ± 19.4	<0.0001
Diastolic Blood Pressure (mmHg)	79.6 ± 11.6	77.4 ± 10.6	82.2 ± 12.1	<0.0001

Table 2. General characteristics of the sample. Qualitative variables (self-reported).

Variable	Total Effective Sample (N = 860) [<i>n</i> (%)]	Women (N = 468) [<i>n</i> (%)]	Men (N = 392) [<i>n</i> (%)]	Women vs. Men <i>p</i> Value
Previous Stroke	8 (0.93)	4 (0.86)	4 (1.02)	0.999 *
History of prior cardiovascular intervention (CABG, stenting)	6 (0.69)	2 (0.43)	4 (1.02)	0.419 *
Family history of cardiovascular disease	230 (26.7)	142 (30.3)	88 (22.3)	0.032
Family history of DM	269 (31.3)	159 (34.0)	110 (28.1)	0.102
Smoking	329 (38.3)	157 (33.6)	173 (44.1)	0.001
Under antidiabetic drug	76 (8.8)	37 (7.9)	39 (10.0)	0.317
Under antihypertensive drugs	186 (21.6)	109 (23.3)	77 (19.6)	0.195
Under lipid lowering drugs	86 (10.0)	47 (10.0)	39 (10.0)	0.963

* Fisher's exact test.

3.2. Blood Glucose, Glycated Hemoglobin and Type 2 Diabetes Mellitus Prevalence

The crude prevalence of DM in the general population was 10.47% (Table 2). Fasting blood glucose values and glycated hemoglobin A1c levels are presented in Table 1. When stratified by sex, fasting glucose levels were higher in men (mean difference -4.74 mg/dL, $p = 0.0088$). Crude prevalence rates were 11.74% (95% CI: 8.42–15.03) in men and 9.40% (95% CI: 6.65–12.15) in women. A total of 72 participants (8.84% of the effective sample) had fasting blood glucose values between 100 and 125.0 mg/dL. An oral glucose tolerance test (OGTT) could be performed in only 47 of these individuals. In this subgroup, the mean fasting glucose was 105.72 ± 11.02 mg/dL; the mean 1 h glucose level (after oral glucose administration) was 206.70 ± 42.13 mg/dL; and the 2 h mean glucose level was 139.74 ± 45.23 mg/dL. As described in the Methods section, the numerator for the prevalence rate included: (a) individuals who reported being diagnosed with diabetes or were undergoing treatment for it without prior diagnosis; (b) participants with fasting glucose values ≥ 126 mg/dL; (c) those with glycated hemoglobin A1c values $\geq 6.5\%$; and/or (d) individuals with 2 h post-load glucose levels ≥ 200 mg/dL on the OGTT. Based on these criteria, a total of 90 individuals met the requirements to be considered diabetic. Crude and age-standardized prevalence values are shown in Table 3. Type 2 diabetes prevalence increased with age (Figure 1): using the 20–39 age group as the reference (prevalence ratio = 1.00), the ratio rose to 3.48 (95% CI: 1.85–6.55) in the 40–59 age group, and to 6.16 (95% CI: 3.31–11.42) in those aged 60–79 years. Sixty-nine participants from the effective sample (8.02%) reported being aware of their diabetic condition before undergoing the

biochemical analyses. Slightly more than 23% of participants were unaware of their diabetic status. The age-standardized prevalence to the Argentine population aged 20 to 79 years was 9.87%, higher in men. The prevalence standardized to the WHO reference population was 9.32% (Table 4).

Table 3. Crude and age-adjusted prevalences in total effective sample, in female and male.

Variable	Crude Prevalence in Effective Sample, % (95% CI) N = 860	Crude Prevalence in Women, % (95% CI) N = 468	Crude Prevalence in Male, % (95% CI) N = 392	Age-Adjusted Prevalence in Women, % (95% CI) N = 468	Age-Adjusted Prevalence in Male, % (95% CI) N = 392
Diabetes Mellitus	10.5 (8.4–12.6)	9.40 (6.65–12.3)	11.7 (8.42–15.1)	10.6 (7.47–13.7)	12.1 (8.57–15.6)
Obesity	35.6 (32.4–38.9)	37.4 (33.3–42.3)	32.9 (28.1–37.7)	37.6 (32.0–43.1)	33.3 (27.6–39.1)
Overweigh or obesity	71.5 (68.4–74.6)	68.8 (64.5–73.1)	74.5 (70.1–78.9)	68.5 (61.0–76.0)	74.9 (66.3–83.6)
Arterial hypertension	38.8 (35.5–42.2)	35.9 (31.5–40.4)	42.35 (37.3–47.4)	34.9 (29.6–40.2)	43.7 (37.1–50.4)
Hypercholesterolemia	38.5 (35.2–41.8)	40.8 (36.3–45.4)	35.7 (30.8–40.6)	39.9 (34.3–45.6)	36.5 (30.4–42.5)
Hypertriglyceridemia (≥150 mg/dL)	21.3 (18.5–24.1)	16.9 (13.4–20.4)	26.5 (22.0–31.0)	16.6 (12.9–20.3)	26.8 (21.6–31.9)
Low HDL-c (<60 mg/dL)	81.7 (79.1–84.3)	77.1 (73.2–81.01)	87.3 (83.8–90.7)	77.4 (69.4–85.4)	87.1 (77.9–96.3)
Low HDL-c (<40 mg/dL)	6.86 (5.11–8.61)	6.20 (3.91–8.49)	7.65 (4.89–10.4)	6.31 (4.01–8.61)	7.57 (4.86–10.3)

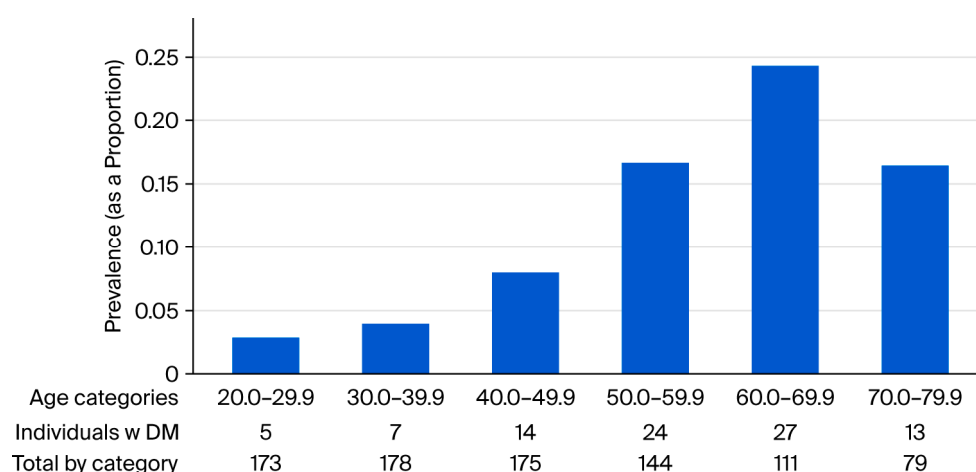


Figure 1. DM prevalence by age category.

Table 4. Age-adjusted prevalence rate to Argentinean and WHO reference populations.

Prevalence	Crude Prevalence in El Trébol	95% CI	Age-Adjusted Prevalence	95% CI
(a) Age-adjusted to Argentinean population				
Total sample (%)	10.5	8.36–12.6	9.87	7.83–11.9
Women (%)	9.4	6.65–12.2	8.84	6.23–11.5
Men (%)	11.7	8.42–15.0	11.1	7.90–14.3
(b) Age-adjusted to WHO population				
Total sample (%)	10.5	8.36–12.6	9.32	7.36–11.3

The prevalence of self-reported diabetes did not significantly differ between phase two responders and non-attenders. In the univariate analyses, no variable was found to be significantly associated with non-response at Phase 2. The variables assessed included self-reported diabetes, age, sex, self-reported hypertension, hypercholesterolemia, personal history of myocardial infarction or stroke, insufficient physical activity, family history of cardiovascular disease or diabetes, education, occupation, alcohol intake, and smoking.

status. Likewise, the multivariable logistic regression model did not identify any significant predictors of non-attendance, with a total model ROC AUC = 0.580, non-significant and a Nagelkerke R² coefficient of 0.028.

Applying IPW resulted in only negligible changes to the crude prevalence estimate (a variation of roughly 0.03% in the Phase 2 prevalence estimate).

3.3. Body Mass Index, Waist Circumference, and Obesity Prevalence

The Body Mass Index (BMI) mean values are shown in Table 1. Crude prevalence of obesity was 35.62% for the total population. Prevalence rates were higher in women. Considering overweight patients as those individuals with an equal or greater BMI than 25 Kg/m², the prevalence rates of overweight are presented in Table 3 for the total effective sample, as well as stratified by sex and adjusted for age. A high proportion of individuals were classified as overweight, with higher rates observed in men (Table 2). As expected, the prevalence of obesity was significantly higher in individuals with DM: 31.68% vs. 68.89% ($p < 0.001$). Mean waist circumference values are presented in Table 1 for the total population and by gender. Waist circumference was significantly different in individuals with DM. On average, individuals with DM had a much larger waist circumference than those without diabetes: 105.34 ± 17.44 cm compared with 90.35 ± 16.72 cm in non-diabetic participants ($p < 0.001$).

3.4. Hypertension

Individuals were diagnosed with hypertension if they had blood pressure readings above 140/90 mmHg, or if they had lower values while receiving antihypertensive medication. Mean systolic and diastolic blood pressure values are presented in Table 1, whereas Table 3 shows individuals undergoing antihypertensive treatment. A difference between sexes was observed, with men showing higher values than women. This difference was particularly notable in systolic blood pressure, with men averaging approximately 10 mmHg higher than women. Prevalence of hypertension was higher in persons with diabetes: 70.00% vs. 35.19% ($p < 0.001$).

3.5. Dyslipidemia

Individuals were classified as having dyslipidemia if they were either undergoing pharmacological treatment for the condition or, in the absence of medication, had any of the following lipid values: total cholesterol ≥ 200 mg/dL, triglyceride ≥ 150 mg/dL, HDL cholesterol < 40 mg/dL, or LDL cholesterol ≥ 130 mg/dL. The average values for lipid parameters are shown in Table 1. Although no significant differences were observed between sexes overall, a statistically significant difference was found in triglyceride levels, with men showing values approximately 23 mg/dL higher than women. Prevalence rates are presented in Table 2, while data on patients receiving lipid-lowering treatment are provided in Table 3. Prevalence of LDL cholesterol levels above or equal to 130 mg/dL was 19.42%, without significant difference between genders. LDL cholesterol equal to or higher than 100 mg/dL was found in 51.86% of the effective sample (no gender difference). LDL did not differ in individuals with diabetes compared with those without it. Triglyceride levels were higher in diabetic participants (190.27 ± 151.27 vs. 112.97 ± 89.29 mg/dL), and HDLc mean values were lower.

Even considering the elevated prevalence of individuals with hyperlipidemia, only 10.00% of them reported being treated with lipid-lowering agents (22.22% in people with DM, 8.57% in non-diabetic participants).

3.6. Physical Activity

According to self-reported data, only 16.16% of study participants reported engaging in 150 min or more of physical activity per week. The prevalence of insufficient physical activity was significantly higher among individuals with diabetes (96.67%) compared to non-diabetic individuals (82.34%) ($p < 0.001$).

3.7. Other Risk Factors

A 38.26% of the sample reported being smokers, with a significantly higher prevalence among males. Excessive alcohol consumption was self-reported by 40.93% of respondents, with no significant differences observed between diabetic and non-diabetic individuals.

3.8. Multivariate Analysis

General demographics (age and sex), anthropometric data (BMI), lipid values (including cholesterol, triglycerides and HDLc), blood pressure data and physical-performance-related variables (physical activity ≥ 150 min per week and smoking habit) were introduced as covariates in a multiple logistic regression model, with presence of DM as dependent variables (Table 5). DM was independently associated with: age (a risk increase of 5.3% per year), BMI (7.7% risk increase per Kg/m²), triglyceride levels (0.5% increase in risk per mg/dL), HDLc (a reduction in risk of 5.4% per each mg/dL) and with physical activity (a 34.2% risk reduction was observed in those who engaged in 150 or more minutes of physical activity per week). No significant associations were found with the rest of the included variables.

Table 5. Association between DM and other independent covariates. Multiple logistic regression (Dep Var: DM) *.

Covariate	Beta Coefficient	Standard Error of Beta	Odds Ratio	95% CI	p Value
Constant	−0.236	1.557	-	-	0.135
Age (per yr)	0.517	0.010	1.05	1.03–1.07	<0.001
Gender	0.332	0.273	1.39	0.82–2.38	0.223
BMI (per kg/m ²)	0.073	0.018	1.08	1.04–1.12	<0.001
Cholesterol (per mg/dL)	−0.001	0.004	0.10	0.99–1.01	0.775
Triglycerides (per mg/dL)	0.004	0.009	1.01	1.00–1.01	<0.001
HDL (per mg/dL)	−0.055	0.001	0.95	0.91–0.98	0.003
Systolic blood pressure (per mmHg)	−0.004	0.008	0.10	0.98–1.01	0.599
Diastolic blood pressure (per mmHg)	0.007	0.015	1.01	0.98–1.04	0.615
Physical activity (≥ 150 min/week)	−0.418	0.129	0.66	0.51–0.85	0.001
Smoking	−0.329	0.255	0.73	0.44–1.19	0.196

* Null model −2 Log likelihood: 576.517; Full model −2 Log likelihood: 435.233; Chi2: 141.283; df: 12; $p < 0.001$; Cox & Snell R2: 0.15; Nagelkerke R2: 0.31.

4. Discussion

This study is the first to report the prevalence of DM and associated cardiovascular risk factors in El Trébol, a small urban community in Argentina. This study offers valuable insights into the burden of metabolic disease in underrepresented populations. Using a two-phase strategy combining household surveys with laboratory assessments, we found a crude prevalence of DM of 10.47%, with higher rates in men and a clear increase with age (Table 3 and Figure 1). These findings are consistent with other national and regional estimates: the 3rd Venado Tuerto survey reported a prevalence rate of 11.4% in 2027, while the most recent IDF Diabetes Atlas estimated a prevalence of 10,1% in 2024 for South and Central America among adults aged 20–79 years old. However, many previous estimates have relied primarily on self-reported data. The 4th ENFR, 2018 [2] reported a combined prevalence of ‘high glucose levels or DM’ of 10.9%, without dissection between these two

categories, a strong effect of self-reported data, and with difficulties in estimating the percentage of patients who were unaware of the presence of the disease. Therefore, by incorporating direct laboratory measurements rather than relying solely on self-reports, our study avoids the potential overestimation bias present in many prevalence studies, providing more robust and reliable estimates.

4.1. Prevalence of Diabetes Mellitus

According to the IDF, 30.4% of people in South and Central America and 42.8% worldwide are unaware of their DM diagnosis [1]. This unawareness imposes a great health risk as people with diabetes are at higher risk of developing medical complications such as microvascular complications, retinopathy, neuropathy and nephropathy, as well as macrovascular ones, including cardiovascular disease and peripheral arterial disease. Unawareness limits the opportunities for lifestyle interventions and risk factor management by the healthcare team. The unawareness rate is consistent with the proportion found in Venado Tuerto, Santa Fe, Argentina [5], lower than the IDF-expected frequency for Latin America, which may suggest a relevant regional variability in diabetes detection, likely influenced by differences in sociodemographic factors and healthcare access.

4.2. Cardiometabolic Risk Factors and Their Association with DM

As has been described in other studies at the local, regional, and global levels, prevalence rates have increased substantially over the past 40 years. In Argentina, the Venado Tuerto study shows a series of rising prevalence rates from the mid-1990s until its latest report in 2018 [5]. However, the data presented in this study from El Trébol (2024) do not show a substantial difference in prevalence rate compared to those from Venado Tuerto (2018) [5]. New studies with serial prevalence measurements will be necessary to determine whether a stabilization in prevalence rate is truly occurring, or if this finding is attributable to differences between studies or to random fluctuations.

It is widely recognized that obesity's global prevalence has reached concerning levels, with numerous studies highlighting its impact on public health. The World Obesity Atlas 2025 estimates that by 2030, half of adult males and females will be living with high BMI [10]. In the same year, 17% of males and 22% of females will be living with obesity. This metabolic condition is strongly associated with type 2 DM, hypertension, and dyslipidemia (World Obesity Atlas, 2025) [11]. In our sample, the crude prevalence of obesity was 35.62%, with higher rates among women than men (Table 3). These rates are consistent with previous studies carried out with a similar methodology [6–13]. In the El Trébol study, considering an obesity definition based on BMI, it was described that a gender-related pattern existed where the prevalence of obesity was 42.2% among females and 26.7% among males. However, mean BMI values did not differ between genders. When considering the combined prevalence of overweight and obesity, the prevalence increases notably, reaching 71.48% in our general sample, 68.80% in females, and 74.49% in males (Table 3). Waist circumference was significantly higher in male participants (with a mean difference close to 4 cm). The high number of individuals with overweight and obesity demonstrates the existence of a clear cardiometabolic risk pattern in our population, as well as a clear association of BMI and waist circumference with the prevalence of diabetes.

Hyperlipidemia was also highly prevalent in our study. There was an overall prevalence of 15.58% on hypertriglyceridemia and 38.49% on hypercholesterolemia, and only half of the sample showed LDL cholesterol levels below 100 mg/dL. Most of the surveyed individuals presented HDL cholesterol levels below 60 mg/dL, and 6.86% on HDL < 40 mg/dL. As in many other studies, triglyceride levels and HDL cholesterol were significantly associated with the presence of DM [11]. Of note, just one third of the individuals identified as

hypercholesterolemic declared to receive medication for the treatment of this entity. Even under treatment, hypercholesterolemia was more frequent in people with DM, these data suggest that a relevant proportion of persons with diabetes are insufficiently treated [14]. This situation has been also referred to in other community-based studies [15].

In our study, the crude prevalence of hypertension was 38.83%, with a significantly higher proportion in men compared to women, a difference that persisted even after age adjustment (Table 2). In the measurements, men presented with higher mean systolic and diastolic blood pressure values (Table 1). Despite this high prevalence, only 21.63% of participants reported receiving antihypertensive treatment, with lower treatment rates observed among men than women (Table 3). Therefore, male participants had higher systolic pressure, and they were less treated than their female counterparts, which highlighted a clear public health necessity to address, even when individuals with DM were more frequently treated (almost half declared receiving at least one medication to treat hypertension), and this is another signal of insufficient management of cardiovascular risk. According to Argentina's 4th National Risk Factor Survey 2018 [4], the national prevalence of hypertension is estimated at 34.6%, although only 24.2% of diagnosed individuals have their condition under control, with better control rates observed in women. Additionally, the PURE (Prospective Urban Rural Epidemiology) study [16] indicated that in rural areas of Argentina, hypertension was more prevalent, less frequently diagnosed, and less treated, particularly in males. These findings are consistent with our results, which reinforced a significant burden of hypertension diagnoses and treatment in small communities of Argentina such as El Trébol. Taken together, our results and the existing literature point to a critical gap in access to care and follow-up, and underscore the need for targeted strategies sensitive to both gender and geographic context.

Overall, our findings confirm a close to 10% prevalence of DM in the surveyed population, as well as a strong association of DM with age, obesity, hypertension, dyslipidemia, and physical inactivity, reflecting the clustering of cardiometabolic risk factors previously described in Argentina and globally. This work also highlights the importance of conducting periodic community-based prevalence studies in order to confirm and complement the information provided by National Risk Factor Surveys. Finally, insufficient physical activity was declared by most of the surveyed individuals, and only 16.16% of them reported performing at least 150 min of moderate aerobic activity per week.

4.3. Strengths and Limitations

The main strengths of this study include its multistage, systematic, randomized sampling strategy, the high participation rate, and the use of biochemical measurements for case definition. These features enabled detection of undiagnosed DM and provided reliable prevalence estimates while simultaneously assessing comorbid conditions and lifestyle factors. Compared with the ENFR, which relies heavily on self-report, our design offers a more accurate and comprehensive evaluation of the burden of DM at the community level. In addition, situating these findings within the global context is essential: according to the IDF Diabetes Atlas [1], more than 589 million people worldwide live with diabetes, a figure projected to rise steadily in the coming decades. At the regional level, our results are consistent with those reported in Venado Tuerto, another city in Santa Fe province, which reinforces both the robustness and the external validity of our estimates [5].

Several limitations should be acknowledged. First, although the participation rates were high, attrition between the household survey and the clinical phase may have introduced selection bias. As mentioned, in population-based studies using a two-phase sampling design, there is a risk that non-attenders differ systematically from attenders. In our study, we reported a 'crude' (unadjusted) prevalence of self-reported diabetes of

8.09% in the household survey and 8.02% in the effective sample, with no significant difference. Although the prevalence of diabetes was numerically lower in the effective sample, we applied a set of statistical procedures to assess the potential misestimation of diabetes prevalence due to differential participation between Phase 2 attenders and non-attenders, as described in the Methods section. In the univariate analyses, we did not identify any variable significantly associated with non-response. The variables examined included self-reported diabetes, age, sex, self-reported hypertension, hypercholesterolemia, personal history of myocardial infarction or stroke, insufficient physical activity, family history of cardiovascular disease or diabetes, education, occupation, alcohol consumption, and smoking status. Multivariable logistic regression also showed no significant predictors of non-attendance. Application of IPW produced only minimal changes in the crude prevalence estimate (expected modification of approximately 0.03%). In our view, although response bias cannot be entirely ruled out, the analytical results indicate that the use of the crude prevalence obtained from the effective sample was sufficiently robust to proceed with standardization and subsequent analyses. Second, this study focused on a limited cohort from a single small city in the province of Santa Fe, which limits the possibility of extrapolating the results to the rest of the province or the country. Nevertheless, our findings are supported and contextualized by international studies referenced in the discussion. Third, some participants from the initial household survey were lost to follow-up, and therefore their laboratory measurements could not be obtained, which may have influenced prevalence estimates. Fourth, the cross-sectional design precludes establishing causal inference. Although, most variables were obtained from direct clinical or biochemical assessments, some information (e.g., demographic data, personal and clinical history) relied on self-reported responses. That said, despite clear explanations and informed consent, physical activity and alcohol consumption were assessed through self-reported questionnaire data and may therefore be subject to recall bias and social desirability bias, potentially limiting accuracy. As OGTT was not completed in all participants with impaired fasting glucose, some cases of diabetes may not have been detected, potentially leading to a slight underestimation of true prevalence.

Despite these limitations, this study provides valuable, high-quality epidemiological evidence that complements national surveillance systems and contributes to the understanding of the diabetes burden at both local and global levels.

4.4. Public Health Implications

The findings of our study carry important implications for public health in Argentina. The identification of undiagnosed DM and the high prevalence of coexisting risk factors highlight the urgent need to strengthen early detection and integrated management strategies at the primary care level. Our results demonstrate that community-based, laboratory-confirmed surveys can reveal a more accurate picture of disease burden than self-report-based instruments such as the ENFR. At the local level, these findings support the strengthening of primary-care-based screening strategies, including opportunistic glucose testing in adults with obesity, hypertension, or sedentary lifestyles. Community-level interventions promoting physical activity and weight management, along with periodic laboratory-confirmed surveillance, may facilitate earlier detection of undiagnosed diabetes and more effective allocation of healthcare resources. Incorporating systematic, multistage, randomized studies into Argentina's surveillance system would allow for more precise monitoring of regional disparities, better resource allocation, and the design of targeted interventions. Such an approach is particularly relevant in the current context of socioeconomic inequality, where vulnerable populations face structural barriers to prevention and care. Scaling up this methodology could therefore enhance the effectiveness of national

chronic disease policies, reduce health inequities, and improve long-term outcomes for individuals at risk of diabetes and cardiovascular disease.

Primary health care plays a key role in the early detection of type 2 diabetes mellitus, particularly in small and medium-sized communities. Opportunistic screening in primary care settings, especially among individuals with obesity, hypertension, or sedentary lifestyles, may facilitate earlier diagnosis and timely intervention. Strengthening primary care-based screening and follow-up could therefore contribute to reducing the burden of undiagnosed diabetes and its long-term complications.

5. Conclusions

In conclusion, this study provides valuable epidemiological evidence regarding the prevalence of DM, hypertension, hyperlipidemia, and obesity in the town of El Trébol, Santa Fe, Argentina, an area with limited prior data. The observed rates of these metabolic conditions, particularly the high prevalence of hypertension and excess body weight, along with significant sex-based differences and low levels of treatment coverage, reflect a concerning cardiometabolic risk profile within this rural population. Unlike national surveillance systems such as the ENFR, which rely heavily on self-reporting (≥ 110 mg/dL capillary glucose or prior diagnosis/treatment) and thus underestimate true prevalence, our multistage, laboratory-confirmed design enabled detection of undiagnosed cases and provided more robust, community-level estimates. Similarly, compared with IDF projections, which compile heterogeneous sources ranging from peer-reviewed studies to WHO STEP surveys, our study offers locally validated and methodologically rigorous data. These strengths underscore the value of our findings not only as complementary to national and international indicators, but also as evidence to guide locally adapted public health interventions, with particular attention to early diagnosis, gender-specific approaches, and improved access to health care, especially in rural areas where structural barriers often limit preventive care and long-term follow-up. This study represents a meaningful contribution toward filling the epidemiological gap in central Argentina and supports future research and health planning efforts at the community level.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/diabetology7030049/s1>, File S1: Household survey questionnaire used in the El Trébol 2024 study; File S2: STROBE.

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Abbreviations

DM	Diabetes Mellitus
BMI	Body Mass Index
HDL	High-Density Lipoprotein
HDL-c	High-Density Lipoprotein Cholesterol
LDL	Low-Density Lipoprotein
LDL-c	Low-Density Lipoprotein Cholesterol
ENFR	Risk Factor's National Survey
IDF	International Diabetes Federation
HbA1c	Glycated Hemoglobin
OGTT	Oral Glucose Tolerance Test
CM	Clinical Chemistry
ADA	American Diabetes Association
WHO	World Health Organization
CI	Confidence Interval
NCE-ATP III	National Cholesterol Education Program (Ncep)—Adult Treatment Panel III (Atp III)
OR	Odds Ratio
<i>p</i> value	Probability Value
CABG	Coronary Artery Bypass Grafting
PURE	Prospective Urban Rural Epidemiology
IPW	Inverse Probability Weighting

References

1. IDF Diabetes Atlas 2025. Diabetes Atlas. 2025. Available online: <https://diabetesatlas.org/resources/idf-diabetes-atlas-2025/> (accessed on 11 September 2025).
2. Saeedi, P.; Petersohn, I.; Salpea, P.; Malanda, B.; Karuranga, S.; Unwin, N.; Colagiuri, S.; Guariguata, L.; Motala, A.A.; Ogurtsova, K.; et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Res. Clin. Pract.* **2019**, *157*, 107843. [CrossRef] [PubMed]
3. Rao Kondapally Seshasai, S.; Kaptoge, S.; Thompson, A.; Di Angelantonio, E.; Gao, P.; Sarwar, N.; Whincup, P.H.; Mukamal, K.J.; Gillum, R.F.; Holme, I.; et al. Diabetes mellitus, fasting glucose, and risk of cause-specific death. *N. Engl. J. Med.* **2011**, *364*, 829–841. [CrossRef] [PubMed]
4. Instituto Nacional de Estadística y Censos de la República Argentina. 4° Encuesta Nacional de Factores de Riesgo. Resultados definitivos. In *Secretaría de Gobierno de Salud de la Nación, Argentina*; Nivel 4: Tema 4.32.68; INDEC: Buenos Aires, Argentina. Available online: <https://www.indec.gob.ar/indec/web/Nivel4-Tema-4-32-68> (accessed on 12 September 2025).
5. Corna, R.; Fox, A.; Ranalli, C.; Ranalli, M.; Sandrigo, S.; Belbuzi, C.; Maestu, F.; Bolognesa, M.; Río, E.; Medina, R.; et al. Prevalencia de diabetes, obesidad y otros factores de riesgo cardiovascular. Estudio Venado Tuerto 3 (VT3). *Alad* **2022**, *11*, 101–109. Available online: https://www.revistaalad.com/frame_esp.php?id=463 (accessed on 15 September 2025). [CrossRef]
6. Sereday, D.; Gonzalez, C.; Giorgini, D.; De Loreda, L.; Braguinsky, J.; Cobeñas, C.; Libman, C.; Tesone, C. Prevalence of diabetes, obesity, hypertension and hyperlipidemia in the central area of Argentina. *Diabetes Metab.* **2004**, *30*, 335–339. [CrossRef] [PubMed]
7. Yameny, A.A. Diabetes Mellitus Overview 2024. *J. Biosci. Appl. Res.* **2024**, *10*, 641–645. [CrossRef]
8. Mancini, M.C.; Ruiz, M.; Irazola, V. Epidemiología de la diabetes en la Argentina. *Av. Diabetol.* **2010**, *26*, 203–210. [CrossRef]
9. National Heart, Lung, and Blood Institute. *The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*; National Institutes of Health: Bethesda, MD, USA, 2004. Available online: <https://www.nhlbi.nih.gov/files/docs/guidelines/jnc7full.pdf> (accessed on 12 September 2025).

10. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *J. Am. Med. Assoc.* **2001**, *285*, 2486–2497. [[CrossRef](#)] [[PubMed](#)]
11. World Obesity Atlas. 2025. Available online: <https://data.worldobesity.org/publications/world-obesity-atlas-2025-v7.pdf> (accessed on 23 October 2025).
12. Marro, M.J.; Cardoso, A.M.; Leite, I.C. Desigualdades regionales en la mortalidad por diabetes mellitus y en el acceso a la salud en Argentina. *Cad. Saúde Pública* **2017**, *33*, e00113016. [[CrossRef](#)] [[PubMed](#)]
13. Ríos-Fetchko, F.; Fernández, A.; Mejía, R.; Salgado, M.V. Disparities in regional obesity rates in Argentina by socioeconomic status. *Medicina* **2023**, *83*, 366–375. Available online: <https://pubmed.ncbi.nlm.nih.gov/37379533/> (accessed on 30 July 2025). [[PubMed](#)]
14. Tohidi, M.; Asgari, S.; Chary, A.; Safiee, S.; Azizi, F.; Hadaegh, F. Association of triglycerides to high-density lipoprotein cholesterol ratio to identify future prediabetes and type 2 diabetes mellitus: Over one-decade follow-up in the Iranian population. *Diabetol. Metab. Syndr.* **2023**, *15*, 13. [[CrossRef](#)] [[PubMed](#)]
15. Rossi, A.; Masi, D.; Zilich, R.; Baccetti, F.; Baronti, W.; Falcetta, P.; Morviducci, L.; Musacchio, N.; Muselli, M.; Ozzello, A.; et al. Lipid-lowering therapy and LDL target attainment in type 2 diabetes: Trends from the Italian Associations of Medical Diabetologists database. *Cardiovasc. Diabetol.* **2025**, *24*, 94. [[CrossRef](#)] [[PubMed](#)]
16. Corsi, D.J.; Subramanian, S.V.; Chow, C.K.; Yusuf, S. Prospective Urban Rural Epidemiology (PURE) study: Baseline characteristics of the 90,000 participants. *Int. J. Epidemiol.* **2013**, *42*, 1311–1322. [[CrossRef](#)]

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