The prevalence of type 2 diabetes and prediabetes among armed forces personnel: a systematic review and meta-analysis

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Research article

Keywords: Prevalence, Diabetes mellitus, Prediabetes, Military personnel, police officers

Posted Date: May 18th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-28477/v1

Abstract

Background

Previous studies of diabetes among armed forces personnel did not assess a comprehensive disease prevalence. We conducted a systematic review and meta-analysis to estimate the prevalence of type 2 diabetes and prediabetes among the military personnel and police officers.

Methods

We carried out a systematic search on electronic databases from January 2000 to January 2020. Cross-sectional and cohort studies with a report of the prevalence of diabetes, prediabetes, or both were selected. Random- or fixed-effects model, along with subgroup analysis on diabetes or prediabetes as well as the component of armed forces, was carried out to determine the overall prevalence.

Results

Among 258 citations, 17 studies were entered into the meta-analysis, involving 1559737 individuals. The meta-analysis estimated the prevalence of type 2 diabetes among the police officers (13.78%; 95% confidence intervals [CI]: 10.14–17.60) was higher than that of the military personnel (7.32%; CI: 4.22–10.42). The overall prevalence of prediabetes among the military personnel and the police officers were 7.41% (CI: 3.35–11.48) and 6.30% (CI: 5.11–7.49), respectively.

Conclusion

The prevalence of diabetes and prediabetes among armed forces were consistent with global reports among general population. Future investigations are warranted to estimate the exact prevalence of diabetes among this occupational group.

Background

Diabetes mellitus is a major global health-care challenge. Based on the International Diabetes Federation (IDF) diabetes atlas, 463 million people influenced by diabetes in 2019 worldwide and estimated to be 700 million by 2045 [1]. The expenditure of annual global health on diabetes is approximately USD 760 billion [2]. Diabetes causes a number of micro- and macrovascular complications, as the main reason for morbidity and mortality among patients with diabetes [3]. Furthermore, it significantly affects the life expectancy and quality of patients as well as the development of other diseases [4].

Among risk factors of diabetes, occupation has a crucial role. Nowadays, the relationship between occupational factors and the prevalence of diabetes takes the interest of researchers [5]. Armed forces are at high risk of developing cardiometabolic syndrome because they have unique lifestyles and expose to stressful situations [6]. A body of evidence demonstrated that this occupational group, compared to the general population, had a higher prevalence of metabolic diseases, including diabetes [7, 8]. Additionally, other occupational characteristics, like

dietary regimens, atypical physical activity, long work hours, social isolation, and ergonomic problems, have a negative impact on the health conditions of armed forces personnel [9, 10]. The countries' human development index (HDI) as another remarkable factor impress the quality of life and incidence of many disease among different occupations [11].

The combination of these elements contributes to making negative changes in lifestyle among this occupational group. The results of a cohort study showed that armed forces are more prone to non-communicable diseases, especially at earlier ages, and they die much earlier compared to other groups [12].

This evidence warrants for more comprehensive strategies of monitoring and screening to reduce the prevalence of diabetes and its burden. Therefore, we carried out a systematic review and meta-analysis of relevant studies to improve the understanding and knowledge of the prevalence of type 2 diabetes and prediabetes among different components of armed forces personnel (military personnel and police officers) around various geographical parts of the world.

Methods

The current study is a systematic review and meta-analysis conducted to estimate the prevalence of prediabetes and diabetes among armed forces personnel in 2020. The study carried out based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [13].

Literature Search

A comprehensive literature search of published studies was conducted using Medline/PubMed, Scopus, Embase, ProQuest, and Web of Knowledge, as well as Google Scholar in January 2020. The medical subject headings (MeSH) keywords included "army", "military", "soldiers", "police", "policemen", "cop", "conscript" "diabetes", "prediabetes", "metabolic syndrome", and "prevalence". The keywords dashboard in title and abstract is represented in supplementary material. All articles list were imported to EndNote X7 (Thomson Reuters, Carlsbad, CA, USA) library and the duplicates were automatically removed. Moreover, the references list of included studies were manually searched to ensure satisfying coverage.

Selection criteria

The primary screening was performed according to the title and abstract, by two independent researchers (MF and SH). After that, data extraction and quality assessment were done by reading the full-test of the remaining articles. In the case of conflict in any of the secondary stages, the corresponding author (MS) made the final decision.

The primary criterion for including the articles was a report of the "prevalence of diabetes or prediabetes among armed forces". Studies with inappropriate population, estimation of incidence, and non-English language, as well as conference abstracts, poster papers, and editorial, were excluded.

Data extraction

A spreadsheet was prepared using all targeted statistics. This checklist included the name of the first author, year of publishing, time period, location of study, number of participants, and frequency (with lower and upper 95%

confidence intervals) for diabetes and prediabetes.

Quality assessment

The Joanna Briggs Institute (JBI) checklist was applied in order to evaluate the quality of the studies [14]. This appraisal is aimed to estimate the methodological quality and to assess the possibility of bias in the design, conduct, and analysis of studies. The results of the quality assessment are summarized in supplementary material.

Statistical analysis

The Cochran test (with a significance level of < 0.1) in combination with I^2 statistics (with a significance level of > 50%) was used to the heterogeneity of the studies. Thereafter, the random-effects model with the inverse-variance method was applied in the presence of heterogeneity, and the fixed-effects model was used in the absence of heterogeneity. The subgroup analysis was performed in the case of heterogeneity based on the type of disease (diabetes or pre-diabetes), the component of armed forces personnel (military personnel or police officers), and the countries' HDI. All analyses were conducted using STATA software (version 13).

Additional analysis

The meta-regression was utilized due to the high level of heterogeneity of the included studies. One of these subgroup analyses was the country's HDI as a relative index of life expectancy and quality as well as literacy and education. The other subgroups consisted of the mean age of participants, sample size, and publication year of study.

Sensitivity analysis

In order to evaluate the quality and consistency of the findings and to assess the robustness of the obtained results, sensitivity analysis was conducted through deleting each study separately.

Assessing risk of bias

The publication bias was evaluated using the Egger test [15].

Results

Results of the search

The primary stage of searches yielded 258 citations. Additionally, 37 studies also identified through gray literature. After removing duplicates, 92 studies selected to investigate the titles and abstracts, and 70 articles were remained for the full-text review. Of these, 33 studies fulfilled the inclusion criteria. Finally, 17 articles, involving 1559737 individuals, were extracted for the meta-analysis. The reasons for exclusion of 75 papers were irrelevant title (n = 23), studies with inappropriate population (n = 19), not reporting prevalence of either diabetes or prediabetes (n = 10), reporting incidence of either diabetes or prediabetes (n = 2), review or meta-analysis study (n = 4), non-English papers (n = 10), and editorial, conference abstracts, or poster papers (n = 7). The flowchart of the included studies is shown in Fig. 1.

Description of studies

Base on geographical location of 17 included studies, five studies conducted in India [16–20], two in Iran [21, 22], two in Saudi Arabia [23, 24], two in the USA [25, 26], one in Brazil [27], one in Sweden [28], one in Zambia [29], one in Jordan [30], one in Guinea-Bissau [31], and one in Ethiopia [6]. The basic characteristics of the included studies are shown in Table 1.

Table 1
Characteristics of the studies included in the review.

	Author, year	Time period	Study design	Country	Population	Sex	Age	Sample size	Prevalence	
									DM	PDM
1	Masih, 2019 [16]	2017 to 2018	Cross-sectional	India	Police officers	Male	40–60	155	31.6	-
2	Phiri, 2017 [29]	-	Cross-sectional	Zambia	Police officers	Both	-	148	9.1	-
3	Lindman, 2017 [31]	2009 to 2010	Cohort study	Guinea-Bissau	Police officers	Both	19–83	1104	4.1	4.2
4	Tesfaye, 2016 [6]	April to May 2015	Cross-sectional	Ethiopia	Federal police commission	Both	18–55	936	5.0	8.0
5	Moline, 2016 [25]	Mar 2008 to Jun 2010	Cross-sectional	USA	Law enforcement officers	Both	≥ 40	2497	14.0	-
6	Crump, 2016 [28]	1969 to 1979	Cohort study	Sweden	Military conscripts	Male	18	1547478	0.8	-
7	Afifi, 2015 [23]	2010 to 2011	Cross-sectional	Saudi Arabia	Armed force recruits	Male	40–54	117	21.4	-
8	Filho, 2014 [27]	2012	Cross-sectional	Brazil	Military police corps	Male	42–57	451	10.6	-
9	Yoo, 2013 [26]	-	Cross-sectional	USA	Law enforcement officers	Male	22–60	106	17.9	-
10	Kumar, 2013 [17]	July to Nov 2011	Cross-sectional	India	Police officers	Both	20–59	1817	15.0	6.8
11	Thayyil, 2012 [18]	-	Cross-sectional	India	Police officers	Male	26–58	823	7.0	6.7
12	Khoshdel, 2012 [21]	Sep 2010 to Dec 2011	Cross-sectional	Iran	Military Parachutists	Male	20–50	96	5.2	4.2
13	Heydari, 2010 [22]	-	Cross-sectional	Iran	Military personnel	Male	20–54	341	1.8	8.5

DM; diabetes mellitus, PDM; prediabetes.

	Author, year	Time period	Study design	Country	Population	Sex	Age	Sample size	Prevalence	
									DM	PDM
14	Tharkar, 2008 [19]	-	Cross-sectional	India	Police officers	Male	≥ 30	318	32.1	-
15	Kumar, 2008 [20]	-	Cross-sectional	India	Police officers	Male	20–60	2160	11.5	6.2
16	Khazale, 2007 [30]	Jan to Dec 2006	Cohort study	Jordan	Military pilots	Male	-	111	0.0	9.6
17	Al-Qahtani, 2005 [24]	2004	Cross-sectional	Saudi Arabia	Military soldiers	Male	20–60	1079	9.9	-

DM; diabetes mellitus, PDM; prediabetes.

Heterogeneity

Considerable inter-study heterogeneity was observed based on the Cochran test and the I^2 index. The results of heterogeneity are expressed in Table 2.

Table 2
Results of heterogeneity among included studies.

Variable	Category	# of studies	Q-value	Df (Q)	I-squared	P-value	Selected model
Diabetes							
Military personnel	High HDI	4	30.06	3	93.3	< 0.001	Random-effect
	Very High HDI	3	129.94	2	98.5	< 0.001	Random-effect
	Overall	7	181.33	6	97.2	< 0.001	Random-effect
Police officers	Low HDI	2	0.94	1	0.0	0.333	Fixed-effect
	Medium HDI	6	132.86	5	96.2	< 0.001	Random-effect
	Very High HDI	2	1.06	1	5.7	0.303	Fixed-effect
	Overall	10	337.91	9	97.3	< 0.001	Random-effect
Prediabetes							
Military personnel	High HDI	3	3.59	2	44.3	0.166	Fixed-effect
	Overall	3	3.59	2	44.3	0.166	Fixed-effect
Police officers	Low HDI	2	12.55	1	92.0	< 0.001	Random-effect
	Medium HDI	3	0.64	2	0.0	0.724	Fixed-effect
	Overall	5	16.40	4	75.6	0.003	Random-effect

Results of the meta-analysis

Prevalence of diabetes

The analysis of pooled data indicated the overall prevalence of diabetes among the military personnel was 7.41% (95% confidence intervals [CI]: 3.35–11.48; I^2 = 97.2%, $p < 0.001$). The results of subgroup analyses showed the very low HDI countries had the highest prevalence of diabetes among the military personnel (9.85%; CI: 1.50–18.20, I^2 = 97.2%, $p < 0.001$). The prevalence of diabetes among the police officers was 13.87% (CI: 10.14–17.60; I^2 = 97.3%, $p < 0.001$). The highest prevalence of diabetes among the police officers was observed in countries with moderate HDI (16.83%; CI: 11.81–21.85, I^2 = 96.2%, $p < 0.001$). The results of the meta-analysis of diabetes prevalence among armed forces personnel are demonstrated in Fig. 2.

Prevalence of prediabetes

The overall prevalence of prediabetes among the military personnel and police officers were 7.32% (CI: 4.22–10.42, I^2 = 44.3%, p = 0.166) and 6.30% (CI: 5.11–7.49, I^2 = 75.6%, p = 0.003), respectively. The highest prevalence of prediabetes among the military personnel was observed in countries with medium HDI (6.50%; CI: 5.80–7.20, I^2 = 0.0%, p = 0.724). Figure 3 demonstrated the results of prediabetes prevalence among armed forces personnel. The prevalence of diabetes and prediabetes among armed forces personnel are compared in countries in Fig. 4.

Results of the meta-regression

The Results of meta-regression demonstrated a significant association between publication year of study and the prevalence of diabetes among military personnel (Reg Coef = 0.056, p = 0.047). However, this was not significantly associated with HDI score (Reg Coef = -8.61, p = 0.388), sample size (Reg Coef = 0.000, p = 0.953), and mean age of the participants (Reg Coef = 0.014, p = 0.912).

On the other hand, the obtained results showed a significant association between the mean age of the participants and the prevalence of diabetes among police officers. (Reg Coef = 0.067, p = 0.041). Such a meaningful finding was not observed for HDI score (Reg Coef = 2.39, p = 0.122), sample size (Reg Coef = -0.000, p = 0.544), and publication year of study (Reg Coef = -0.001, p = 0.989). The overall results of meta-regression for the prevalence of diabetes are shown in Fig. 5 and Fig. 6 among military personnel and police officers, respectively.

Sensitivity analysis

The findings were reanalyzed by deleting each study separately. The results were yielded regarding all outcomes (Table 3).

Table 3
The results of sensitivity analysis.

Omitted study	Prevalence (95% CI)	Omitted study	Prevalence (95% CI)
DM in military personnel		DM in police officer	
Crump, 2016	9.11 (3.97–14.25)	Masih, 2019	12.33 (8.63–16.03)
Afifi, 2015	5.56 (1.55–9.58)	Phiri, 2017	14.39 (10.43–18.35)
Filho, 2014	6.62 (2.46–10.78)	Lindman, 2017	15.02 (11.22–18.81)
Khoshdel, 2012	7.84 (3.35–12.34)	Tesfaye, 2016	15.01 (10.94–19.08)
Heydari, 2010	9.05 (2.91–15.19)	Moline, 2016	13.90 (9.84–17.96)
Khazale, 2007	7.41 (3.35–11.48)	Yoo, 2013	13.53 (9.65–17.40)
Al-Qahtani, 2005	6.46 (2.78–10.15)	Kumar, 2013	13.73 (9.78–17.68)
Combined	7.41 (3.35–11.48)	Thayyil, 2012	14.79 (10.62–18.96)
		Tharkar, 2008	11.88 (8.37–18.38)
		Kumar, 2008	14.30 (9.97–18.64)
		Combined	13.87 (10.14–17.40)
PDM in military personnel		PDM in police officer	
Khoshdel, 2012	8.75 (6.14–11.35)	Lindman, 2017	6.72 (6.05–7.38)
Heydari, 2010	6.56 (1.31–11.81)	Tesfaye, 2016	5.94 (4.74–7.15)
Khazale, 2007	6.57 (2.38–10.76)	Kumar, 2013	6.18 (4.67–7.69)
Combined	7.32 (4.22–10.42)	Thayyil, 2012	6.23 (4.80–7.65)
		Kumar, 2008	6.36 (4.71–8.01)
		Combined	6.30 (5.11–7.49)

95% CI; 95% confidence interval, DM; diabetes mellitus, PDM; prediabetes.

Publication bias

Results of Egger's tests demonstrated a lack of publication bias ($p > 0.05$).

Discussion

To the best of authors' knowledge, this is the first meta-analysis conducted on the prevalence of diabetes and prediabetes among armed forces personnel. Several investigations have reported the prevalence of diabetes and prediabetes among different components of armed forces. However, the result of these studies has demonstrated a range of variability in the prevalence. The reported prevalence of diabetes in armed forces was varied from 0.0–32.1% or even higher, depending on different diagnostic criteria, age, HDI of countries, special diet, and other

environmental factors. The present meta-analysis also indicated that different types of armed forces might play a significant role in the prevalence of dysglycemia.

The obtained results demonstrated that the prevalence of diabetes among the military personnel (7.41%) is lower compare to that of the police officers (13.87%). The highest reported prevalence of diabetes was also related to studies carried out among police officers [16, 19]. The overall prevalence of diabetes among military personnel, not police officers, is under the global prevalence of diabetes (9.30%) [32]. This prevalence is uneven since policemen are expected to be in good shape with regular physical activities. Several previous studies conducted among police officers demonstrated the high prevalence of overweight and obesity made them susceptible to diabetes and heart disease [33, 34]. These risk factors of dysglycemia also were associated with a mean age of study population, and elderly participants were more prone to develop diabetes [34]. These were consistent with the results of meta-regression among police officers.

The most frequent and highly rated stressors might be the other main reasons for the high prevalence of many mental and non-communicable diseases in this occupation group [35, 36]. Moreover, ergonomic problems, long work hours, and particular nutrition regimen should not be underestimated [37, 38]. Recent comprehensive studies also showed the prevalence of metabolic syndrome, and its component is high among policemen relative to the general population [9, 19].

However, the overall prevalence of diabetes among military personnel is lower than that of other components of armed forces. Several studies reported that diabetes only affected less than two percent of this occupational group [22, 28, 30]. In addition to a more appropriate lifestyle, there are some other factors contributing to the low prevalence of diabetes in the military unit. Men are initially recruited at younger ages and undergo regular medical checkups, physical training, and calorie-controlled diets. Then, those individuals with underlying medical conditions, including central obesity, are exempted from these services or replaced in public services [9, 39]. Hence, some included military personnel in the present investigation might have a better health-related quality of life compared to the police officers or the general population [39].

The results also showed that the prevalence of diabetes among this population is associated with the year of study. There are several other studies that indicated the prevalence of diabetes is increasing, passing the time [40, 41]. These are not only related to the increasing trend of physical inactivity and consumption of unhealthy diet but also progression in diagnostic techniques as well as effective strategies for detection and follow-up people with dysglycemia [42].

Our findings demonstrated that the prevalence of prediabetes among the military personnel and the police officers were 7.32% and 6.30%, respectively. A body of evidence has demonstrated a range of prevalence of dysglycemia in armed forces according to different biochemical criteria. Some studies reported a prevalence of impaired fasting glucose about 30–40%, particularly among police officers [16, 19, 27, 43–45]. However, the overall prevalence of prediabetes in included studies is under the estimated prevalence of the adult population (7.30%) around the world [46]. However, the fasting blood glucose should be screened regularly among armed forces personnel, as an affordable and invaluable biochemical factor, and impaired fasting glucose would be better to consider as a critical index for early detection and prevention of at-risk population.

Strengths And Limitations

The main strength of the current study is that this is the first analysis that showed the prevalence of diabetes and prediabetes among armed forces personnel. This study can supply reliable baseline information and may guide other scholars to design and conduct novel researches.

However, several limitations reflected by some factors of data are confirmed. Sufficient information was not available to conduct separate or subgroup analyses in terms of assessment of all age groups. The lack of data regarding lifestyle, physical activity, and nutritional habits of the participants, which could explain the estimated high prevalence of police officers, is another main limitation. Because of the high level of heterogeneity of the included studies, it was only attempted to analyze the results according to countries' HDI.

Conclusion

In summary, this meta-analysis clearly demonstrated that the prevalence of diabetes and prediabetes among all types of armed forces personnel were consistent with global reports of these diseases among general population. However, the prevalence of diabetes among police officers was relatively high (13.87%). This high prevalence should be considered as a serious alarm. Future large-scale investigations studying the prevalence of diabetes and its associated factors among armed forces personnel would explain the high estimated prevalence of dysglycemia among police officers, and help to take effective strategies in prevention, early detection and management of diabetes among this occupational group.

Abbreviations

CI:95% confidence interval; IDF:International Diabetes Federation; HDI:human development index; PRISMA:Preferred Reporting Items for Systematic Reviews and Meta-Analyses; MeSH:medical subject headings; JBI:Joanna Briggs Institute.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data is presented within the manuscript file.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

All authors were responsible for conceiving and designing the protocol. MF, SH, and MS designed the study. MF and MT did the literature search and, together with SH, selected the studies, extracted the relevant data. SH and MS synthesized the data. MF wrote the first draft of the Manuscript. MS and SA provided critical guidance on the analysis and overall direction of the study. All authors critically revised successive drafts of the paper and approved the final version.

Acknowledgements

Thanks Dr. Maryam Saleh for the invaluable comments on the study and for editing the final draft.

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Figures

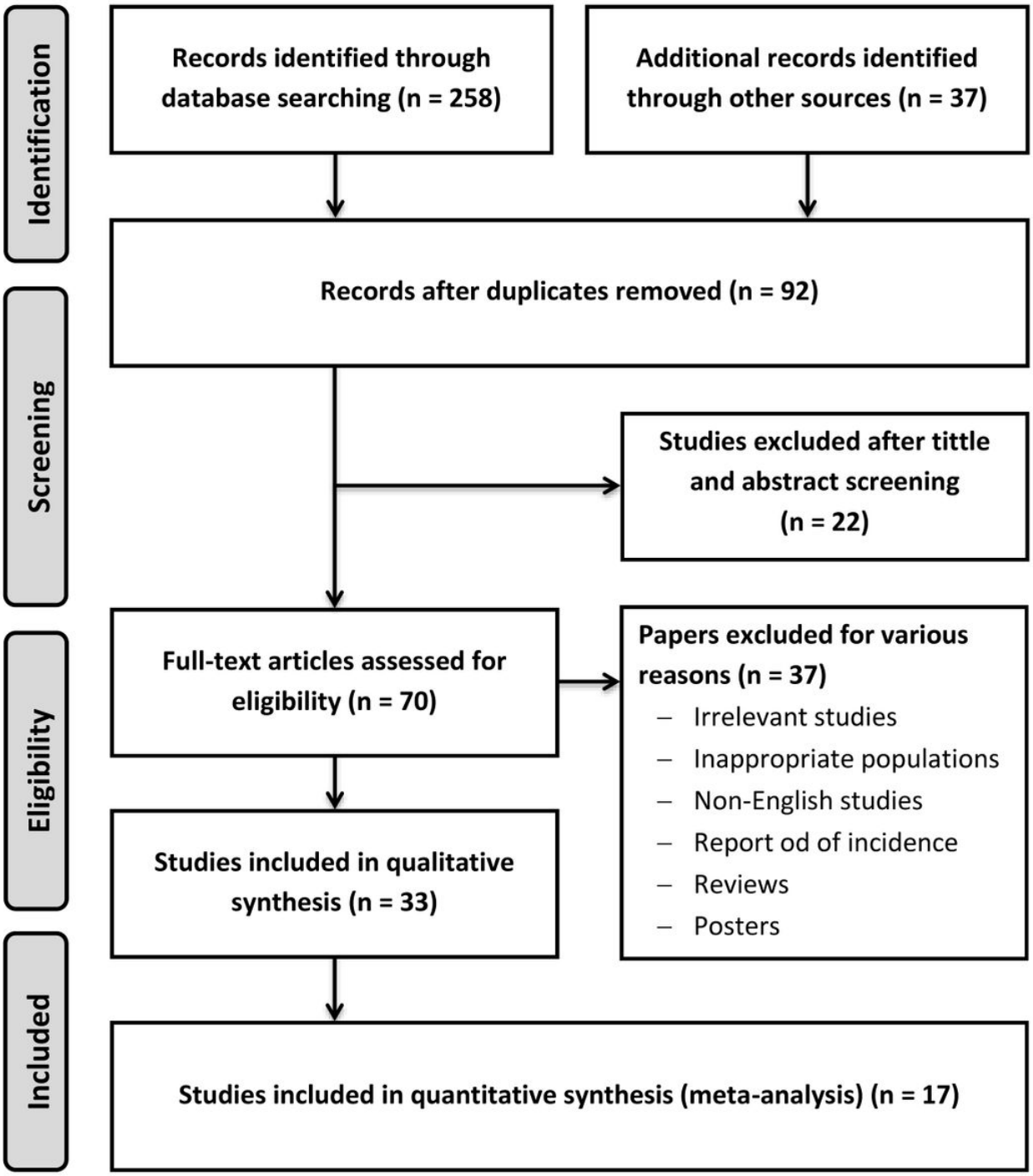

Figure 1

Flowchart of the included studies

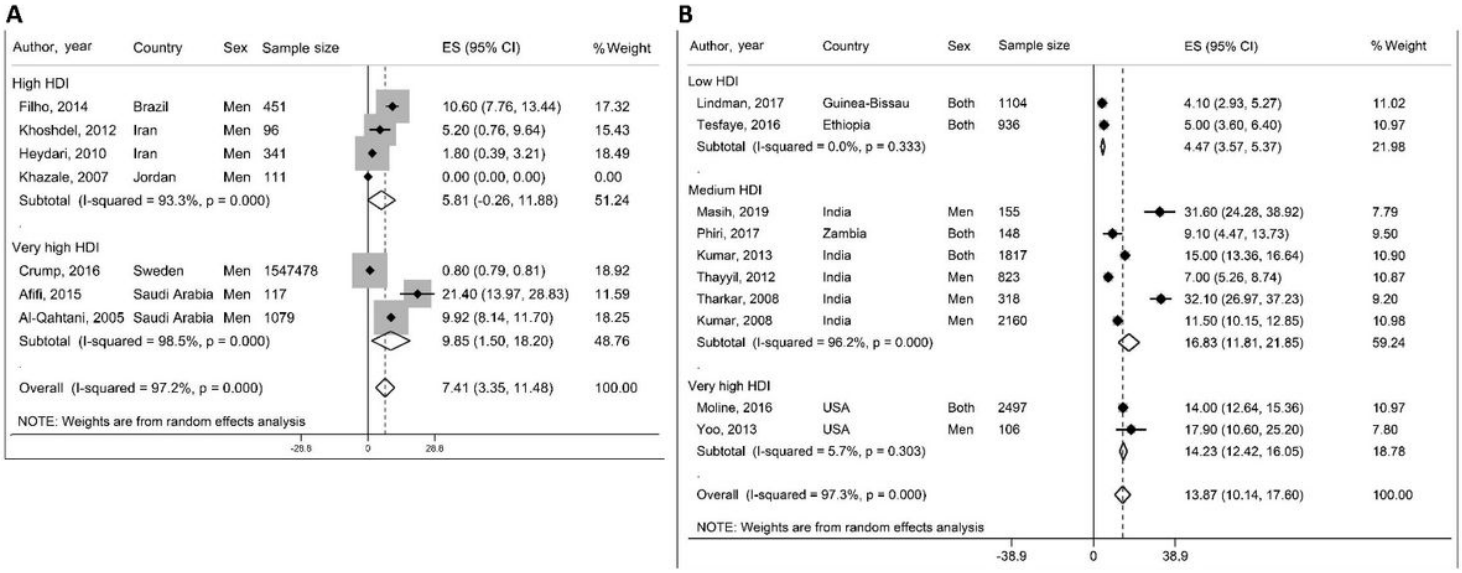

Figure 2

The prevalence of diabetes among the military personnel (A) and police officers (B) stratified by human development index (HDI).

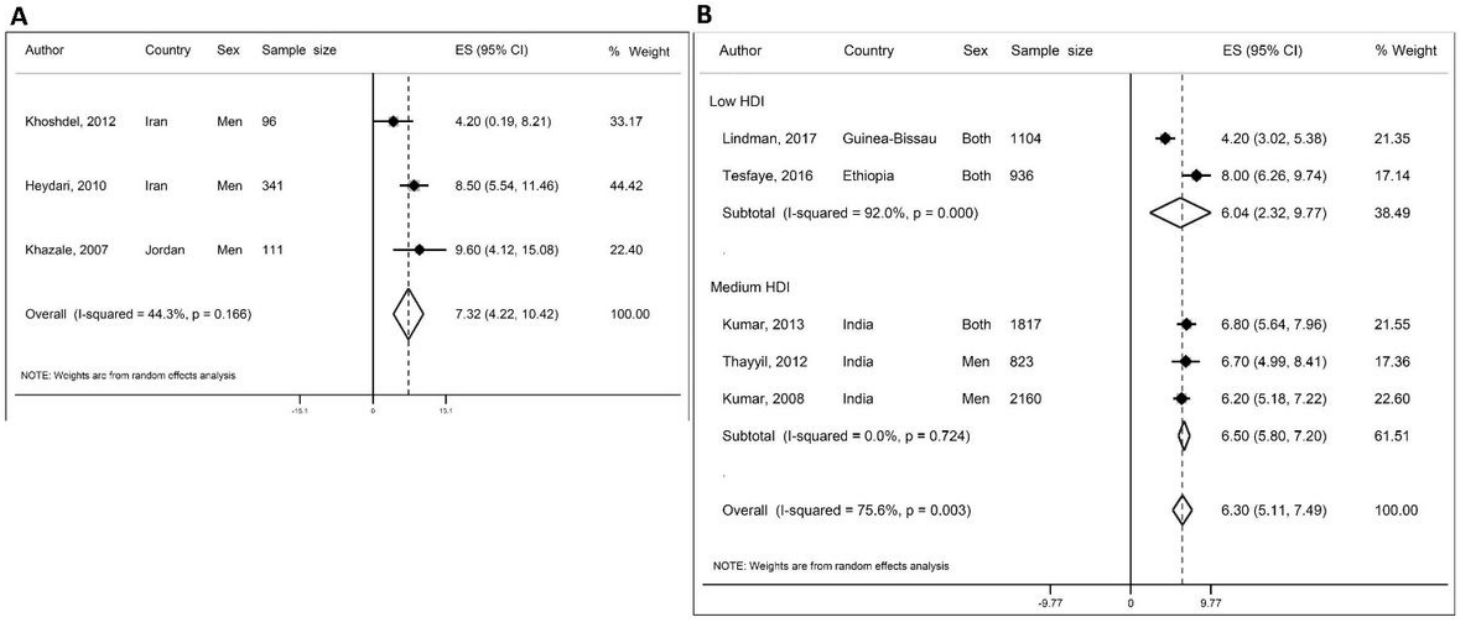

Figure 3

The prevalence of prediabetes among the military personnel (A) and police officers (B) stratified by human development index (HDI).

Figure 4

Prevalence of diabetes (top) and prediabetes (bottom) among military personnel and police officers.

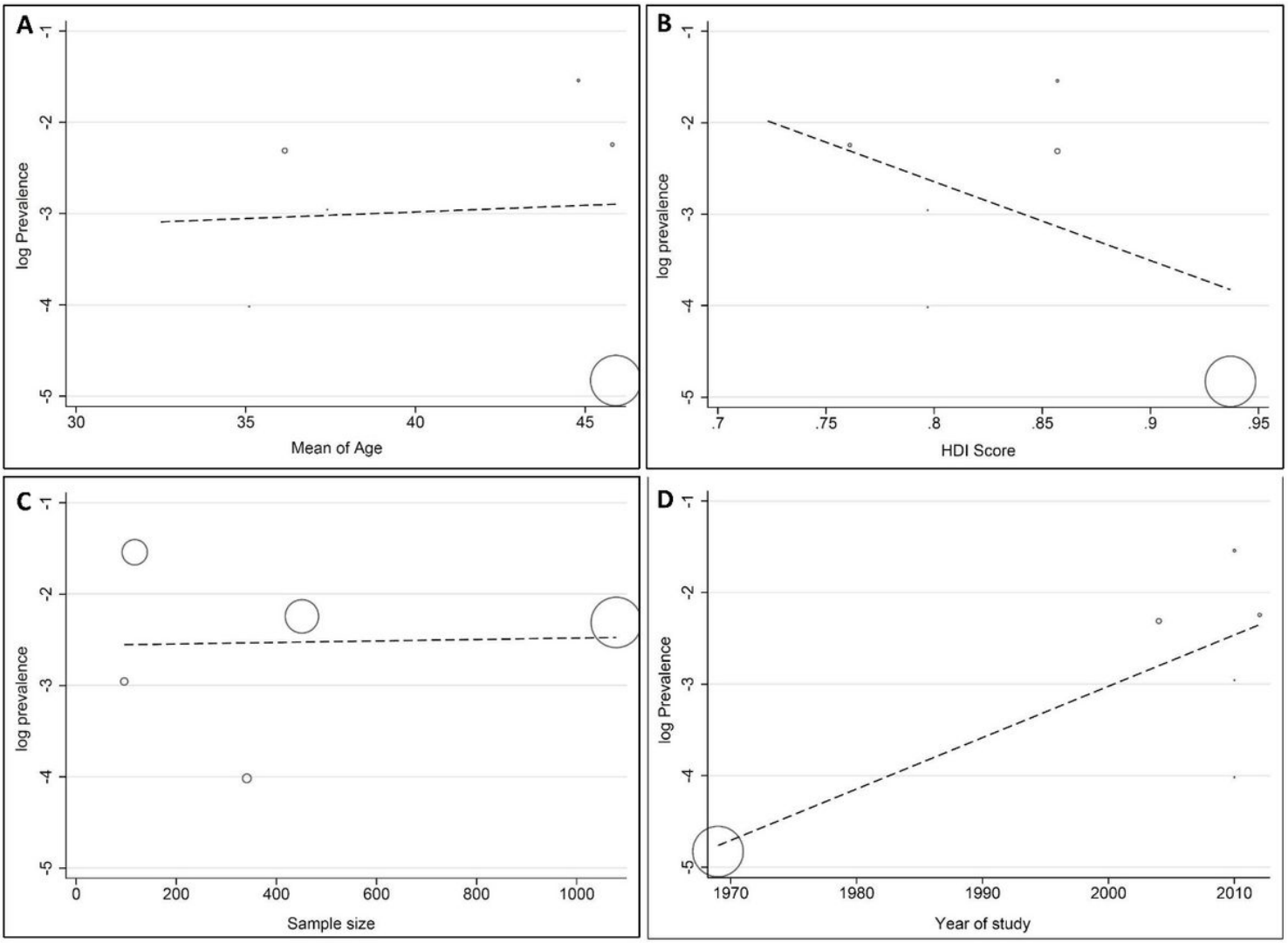

Figure 5

The association between the prevalence of diabetes and mean age of participants (A), Human Development Index score (B), sample size (C), and publication year of study (D) among military personnel.

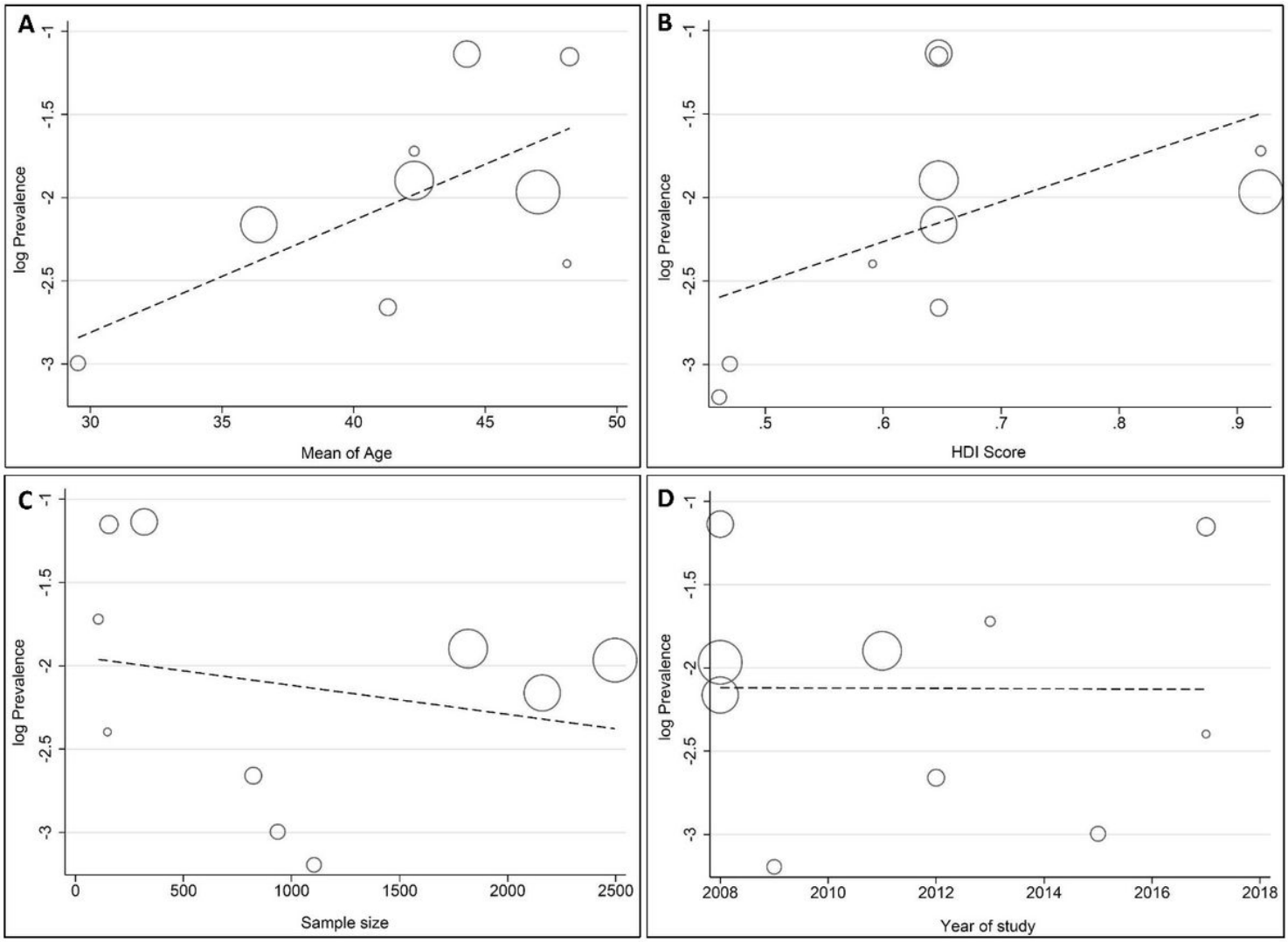

Figure 6

The association between the prevalence of diabetes and mean age of participants (A), Human Development Index score (B), sample size (C), and publication year of study (D) among police officers.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix2.docx
- PRISMA2009checklist.doc
- Appendix1.docx