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Review article

The global burden of overweight-obesity and its association with economic status, benefiting from STEPs survey of WHO member states: A meta-analysis

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ABSTRACT

Introduction: The World Health Organization (WHO) 2030 agenda for Sustainable Development Goals (SDGs target 3.4) identifies non-communicable diseases (NCDs) as a key challenge for sustainable development. As one of the major NCD risks, here, we estimated the prevalence of overweight/obesity in adults and assessed country-economic variations using *meta*-analysis.

Methods: The latest STEPwise approach to NCD risk factor surveillance (STEPS) report of WHO member states studied on overweight/obesity from 2000 to 2020 were reviewed and related data were assessed further. The prevalence of overweight/obesity was pooled using the random effects model. The subgroup analysis and *meta*-regression were performed based on countries' economic status obtained from the World Bank's country development index 2019. Study heterogeneity and publication bias were also observed.

Results: Out of 73 studies with 469,766 participants analyzed, the highest overweight/obesity prevalence was found in American Samoa (93.5 %), while Democratic People's Republic of Korea had the lowest prevalence (4.4 %). The overall weighted pooled prevalence of overweight/obesity regardless of countries economic status was 37.0 % [95 % CI: 33 %-42 %]. There was significant heterogeneity in the prevalence of overweight/obesity ($I2 = 99.91$ %; $p < 0.001$). Subgroup analysis revealed a higher prevalence in high-income countries [60 %; 95 % CI: 47 %-72 %]. Meta-regression revealed a significant ($p = 0.001$) association and a 14 % increase chance of having overweight/obesity with increasing economic status.

Conclusion: The prevalence of overweight/obesity is high worldwide, especially in high-income countries that demands a large-scale awareness campaigns and effective initiatives to control overweight/obesity and the associated risk factors of adults of these countries.

1. Introduction

Overweight/obesity has become one of the major non-communicable diseases (NCDs) risk factors, and this burden as a global pandemic continues to unacceptably rise (Djalalinia et al., 2020). The risk of overweight/obesity was higher in developing and developed countries compared to lower-income countries (YC et al., 2019). According to the World Health Organization (WHO) in 2022, worldwide 2.5 billion (43 %) adults aged 18 years or older were overweight, and 890 million (16 %) of these adults were living with obesity (World Health Organization, 2024a). This burden becomes more than double since 1990 (World Health Organization, 2024a). The relationship

Abbreviations: WHO, World Health Organization; DPR Korea, Democratic People's Republic of Korea; NCDs, Non-communicable diseases; STEPs, STEPwise approach to NCD risk factor surveillance; HRQL, health-related quality of life; PRISMA, Preferred Reporting Items for Systematic reviews, and Meta-Analyses; BMI, Body Mass Index; BP, Blood Pressure; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; GNI, Gross National Income.

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between poor health outcomes and obesity is well-established. Worldwide, more than 2.8 million people die each year as a result of being overweight or obese, and 35.8 million (2.3 %) of global disability-adjusted life years (DALYs) are caused by overweight or obesity (World Health Organization, 2024b).

Globally, overweight/obesity is one of the major public health concerns and it decrease persons' health-related quality of life (HRQL). The existing literature supports that overweight-obesity is negatively correlated with person's HRQL (Chung et al., 2016; Wu et al., 2014). Overweight/obesity is also a significant risk factors of various non-communicable disease like hypertension (Chowdhury et al., 2020, 2018b; Paul et al., 2021), diabetes (Slagter et al., 2015), strokes and other chronic disorders (Chowdhury et al., 2018a; Matalqah et al., 2021; Mondal et al., 2023; Sarkar et al., 2023).

Overweight and obesity carry an economic burden as individuals with these conditions incur higher medical costs than those who are not obese (Withrow and Alter, 2011). In a study of Withrow and Alter, the authors reported that obese individuals were found to have medical costs that were approximately 30 % greater than their normal weight peers (Withrow and Alter, 2011). Overweight/obesity is also associated with person's psychological disorder and studies suggested that obesity may lead to higher vulnerability to mental or physical stressors (Petry et al., 2008; Scott et al., 2012; van der Valk et al., 2018).

The WHO 2030 agenda for SDGs target 3.4 identifies NCDs as a key challenge for sustainable development. As part of the action plan, WHO requests his member states to control and prevention of unconditional probability of deaths due to NCDs for people aged 30–70 years by modifying lifestyle and metabolic risk factors, including overweight-obesity (Djalalinia et al., 2020). The WHO is also designed a STEPwise approach to non-communicable disease risk factor surveillance to help member countries to build and strengthen their surveillance capacity (World Health Organization, 2021). According to the global risk reduction agenda of WHO, having reliable information on NCD risk factors, including overweight/obesity, is critical for establishing, executing, and evaluating National Action Plans at the country level. Despite the wealth of research on this issue, there is a lack of comprehensive, up-to-date global analysis that utilizes standardized, comparable data across countries. This study aims to fill the existing gap by leveraging latest STEPs survey data to provide robust global prevalence estimates of overweight and obesity, while also examining the economic variations across different countries. Understanding these variations is crucial, as the relationship between economic status and obesity is complex and context-dependent. By elucidating these patterns, this study seeks to inform more effective, context-specific public health policies and interventions, ultimately aiming to reduce the global burden of obesity-related diseases and promote health equity.

2. Methods

In this *meta*-analysis, the Preferred Reporting Items for Systematic reviews, and Meta-Analyses (PRISMA)-2020 guideline was followed (Page et al., 2021).

2.1. Ethical consent and permission for data collection

The ethical consent and permission of data collection is not applicable due to the nature of the study.

2.2. STEPS survey and non-communicable disease risk factors

The World Health Organization (WHO) STEPwise approach to surveillance (STEPS) focuses on obtaining core data on the established risk factors of non-communicable diseases (NCDs) that determine the major disease burden (World Health Organization, 2021). It is sufficiently flexible to allow each country to expand on the core variables and risk factors, and to incorporate optional modules related to local or regional interests. The STEPS instrument covers three different levels of "steps" for the assessment of risk factors. These steps are: Step 1 (questionnaire), Step 2 (physical measurements) and Step 3 (biochemical measurements) (World Health Organization, 2021). Following these three steps, the WHO member states consider six major variables for investigation: Current daily smokers, less than 5 servings of fruits & vegetables per day, insufficient physical activity, overweight/obese (Body Mass Index (BMI) $\geq$ 25 kg/m^2), raised blood pressure (Systolic Blood Pressure $\geq$ 140 and/or Diastolic Blood Pressure $\geq$ 90 mmHg or currently on medication for raised blood pressure) and raised total cholesterol ($\geq$5.0 mmol/L) and/or currently on medication. In this study, we *meta*-analyzed overweight/obesity variable which is one of the major NCDs risk factors.

2.3. Data sources and search strategy

The study search period spanned from January to February 2021. During this time, we systematically reviewed the six regional WHO websites for the latest STEPs reports conducted in member states, including all available reports up to January 2021. Initially, 100 countries were found for the STEP surveyed countries. We screened the prevalence of overweight/obesity (BMI$\geq$25 kg/m^2) obtained from the latest STEPS survey reports, data books and fact sheets. For better clarification as well as to assess the impact of national economy on overweight/obesity, selected countries were classified into four groups according to the World Bank's country development index 2019 (gross national income (GNI) per capita in): low-income [GNI: $1,025 or less], lower middle income [GNI: $1,026——3,995], upper middle income [GNI: $3,996——12,375] and high income [GNI: $12,375 or more] (The World Bank, 2019). All the records were managed by Mendeley version 1.19.4 software to exclude duplicates.

2.4. Study selection criteria

There were 120 WHO member countries and 100 conducted STEPS survey for assessing NCDs risks. Initially, reports and fact sheets were gathered to obtain the prevalence of overweight/obese of these countries. Out of 100 countries, 73 were selected according to the selection criteria where 15 were from low-income, 26 were from lower middle-income, 20 were from upper middle-income and 12 were from high income countries. A sum of 27 countries' reports were excluded from the study due to not reporting prevalence of overweight/obese, reported missing and multiple sample size, scientifically weak reporting, and not written in English. The details study screening process are presented in the flowchart (Fig. 1).

2.5. Data screening and extraction

Two independent investigators (MMR and ANMSI) screened the selected 73 STEPS survey reports and extracted information on the prevalence of overweight/obesity. Disagreements were resolved by consulting with the co-authors. The data were extracted from all eligible studies using a standardize form. For each selected studies, STEPS report's publication details [title, year of STEPS survey]; design and population [region, country, age group, sample size]; participants' overweight/obesity (BMI$\geq$25 kg/m^2) prevalence were extracted.

2.6. Statistical analysis

We defined prevalence as the number of cases observed divided by the total sample. Background statistics of the STEPS survey reports were recorded as a tabular form. A random effect model was, therefore, used to perform the *meta*-analysis of the prevalence of overweight/obese (Hossain et al., 2022; Rahman et al., 2022, Rahman et al., 2021). Subgroup analysis was examined according to country's gross national income (GNI) per capita presented by World Bank. Heterogeneity was assessed using Higgin's and Thompson's I^2 statistic and Cochran's Q test.

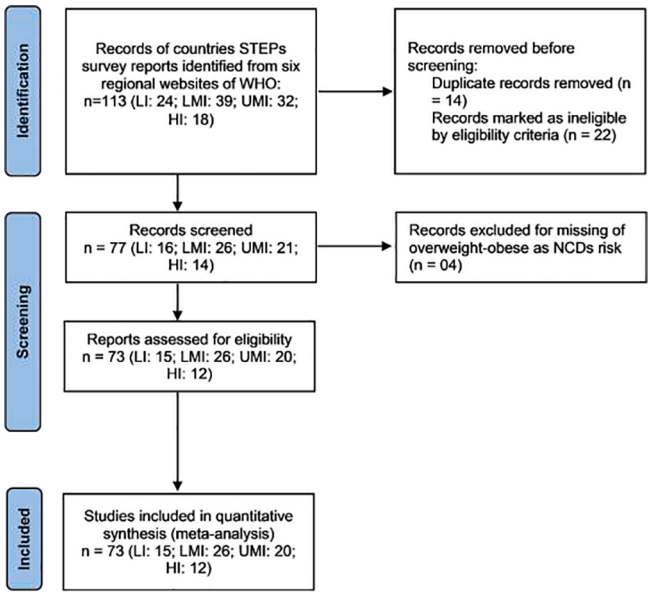


Fig. 1. PRISMA 2020 flow diagram for including STEPS studies in the *meta*-analysis. STEPS: STEPwise approach to NCD risk factors surveillance; LI: Low-income; LMI: Lower middle income; UMI: Upper middle income; HI: High income.

To assess the asymmetry and publication bias, we used funnel plot and Egger test [$p < 0.001$] to test the presence of small-study effects. Meta-regression was also performed to identify the impact of countries economic status (GNI) on the prevalence of overweight/obese. Stata SE version 17.0 (Stata Corporation, College Station, TX, USA 5) was used for all statistical analyses.

3. Results

Out of retrieved 100 WHO surveyed countries, we studied 73 countries STEPs survey reports and excluded 27 countries according to our inclusion and exclusion criteria. The studies selected in this *meta*-analysis comprised 469,766 respondents where 74,871 (15.9 %) were from the low-income countries, 140,599 (29.9 %) were from lower-middle income, 206,229 (43.9 %) were from upper-middle income and 47,997 (10.2 %) were from the high-income countries. The minimum age of the participants was 15 years and above in all the selected studies. Overall, the maximum prevalence of overweight/obesity was 93.5 %%, found in American Samoa where the minimum prevalence observed in Democratic People's Republic (DPR) of Korea (4.4 %). The male prevalence of overweight/obesity were ranged between 4.1 % (DPR Korea) to 92.7 % (American Samoa) while for female, these values were observed 4.7 (DPR Korea and Vietnam) to 94.4 % (American Samoa). The details summary statistics are presented in supplementary Figure S1 and Table 1.

3.1. Global status of overweight/obesity

The weighted pooled prevalence of overweight/obesity regardless of countries economic status was 37.0 % [95 % CI: 33 % – 42 %]. A large amount of heterogeneity was observed in the overall prevalence of overweight/obesity (I^2 = 99.91 %; Cochran Q-statistic $p < 0.001$) (Fig. 2).

3.2. Subgroup analysis based on the economic status of selected countries

Overweight/obesity is correlated with person's economic status and we performed a subgroup *meta*-analysis based on the selected 73 countries economic status, classified based on the World Bank's country development index. In subgroup analysis, the weighted pooled prevalence of overweight/obesity was higher among the participants from high-income countries, 60 % [95 % CI: 47 % – 72 %]. The other weighted pooled prevalence was 21 % [95 % CI: 14 % – 27 %], 27 % [95 % CI: 21 %-34 %] and 52 % [95 % CI: 41 % – 63 %] in low-income, lower middle-income and upper middle-income countries respectively. A significant ($p = 0.001$) high heterogeneity was observed among the participants from all group of economic status (Fig. 3).

3.3. Meta-regression of the prevalence according to countries' economic status

It is evident that the prevalence of overweight/obese can vary according to countries economic status and therefore, an economic effect on the prevalence overweight/obese was also explored by *meta*-regression. Meta-regression showed a significant ($p = 0.001$) increase of weighted pooled prevalence of overweight/obese among participants with the growth of economic status. More specifically, an increase of economic status may lead to 14 % ($p = 0.001$; Fig. 5) rise chance of having overweight/obesity among the participants (Fig. 4 and supplementary result S2).

3.4. Publication bias

We also examined the publication bias among the selected studies obtained by funnel plot. The funnel plot indicates the presence of asymmetry and publication bias (Fig. 5), and Egger test significantly ($p = 0.001$) suggested the existence of small study effects (Supplementary result S3).

4. Discussion

This *meta*-analysis aimed to determine the global prevalence of overweight/obese and its association with countries' economic status, utilizing data from the latest WHO STEPs surveys conducted in member states. The drawback of the study was that STEPS studies conducted only in cross-sectional nature among WHO member states were included in the analysis. We also excluded some STEPS studies that were not reported in English language.

Analysis found that globally, 3.7 out of 10 people were suffering from overweight/obesity disorder. In relation to existing reports, more than one in eight people in the world were living with obesity (World Health Organization, 2024a). According to the recent report, the global overweight/obesity can range from 31 %-67 % among this group of people (World Health Organization, 2024a), and the age-standardized prevalence of obesity was increased globally (NCD Risk Factor Collaboration (NCD-RisC), 2021).

Literature also suggests that females are comparatively more prevalent in overweight/obese than male respondents which align with the current study (Phelps et al., 2024). A high heterogeneity in the global prevalence of overweight/obesity was also observed. This variability may be attributed to socio-demographic factors such as gender, age at first pregnancy, marital status, residence, (AlTamimi et al., 2020; Asif et al., 2020; Rahman et al., 2017). Lifestyle factors including sleep disorders, imbalanced diet, smoking and drag habits, sedentary behaviors and screen time, also contributed to this heterogeneity (AlTamimi et al., 2020; Jezewska-Zychowicz et al., 2018; Rahman et al., 2017; Shin, 2018; Biddle et al., 2017). Furthermore, various environmental factors play a role in this variation (Di Cesare et al., 2016; Myers et al., 2015; Slack et al., 2014).

The subgroup *meta*-analysis revealed that countries with high economic status have a higher prevalence of overweight/obesity, with six out of ten people are suffering from overweight/obesity disorder. Overweight/obese prevalence was also higher in upper middle-income countries, where more than half of the population was found to be overweight and obese. The finding supports the existing literature (Fox

Table 1
Characteristics of studies that evaluated the global prevalence of overweight/obesity.

Economic Status	Country	Year of STEPS Survey	Age Group	Sample Size	Overweight (BMI≥25 kg/m^2) (%)		
					Both	M	F
Low-income	Democratic Republic of the Congo	2005	15–64+	1948	19.1	11.6	24.1
Low-income	Ethiopia	2015	15–69	10,260	6.3	4.4	8.8
Low-income	Gambia	2010	25–64	5280	39.5	33.7	45.3
Low-income	Liberia	2011	25–64	4320	49.9	43	57
Low-income	Madagascar	2005	25–64	5743	12.3	9.4	15.4
Low-income	Malawi	2009	25–64	5760	21.9	6.1	28.1
Low-income	Mali	2007	15–64	2810	34.6	20.7	44.4
Low-income	Mozambique	2005	25–64	3310	21.2	13.5	27.1
Low-income	Niger	2007	15–64	2760	12.7	9.1	16.9
Low-income	Rwanda	2012–13	15–64	7240	14.32	9.1	19
Low-income	Sierra Leone	2009	25–64	5483	22.4	16.2	28.7
Low-income	Uganda	2014	18–69	3987	19.1	11.3	27.1
Low-income	United Republic of Tanzania	2012	25–64	5770	26	15.1	37.1
Low-income	Democratic People's Republic of Korea	2008	25–64	6000	4.4	4.1	4.7
Low-income	Nepal	2013	15–69	4200	21.6	21.2	22.1
Lower middle income	Andhra Pradesh	2007–08	15–64	6270	15	13.4	16.8
Lower middle income	Madhya Pradesh	2007–08	15–65	5922	10.9	9.4	12.6
Lower middle income	Maharashtra	2007–08	15–66	6124	6.6	5.7	7.5
Lower middle income	Mizoram	2007–08	15–67	4495	8.5	6.9	10.5
Lower middle income	Kerala	2007–08	15–68	5067	22.4	20.8	24
Lower middle income	Tamil Nadu	2007–08	15–69	5177	17.7	16.3	19.3
Lower middle income	Uttarakhand	2007–08	15–70	5444	11.3	10.1	12.6
Lower middle income	Indonesia	2006	25–64	2200	13.8	10.4	17.6
Lower middle income	Swaziland	2014	15–69	4320	43.8	26	59.9
Lower middle income	Mongolia	2013	15–64	6150	54.4	49	59.9
Lower middle income	Morocco	2017	18–69	6100	53	42.6	63.4
Lower middle income	Bhutan	2014	18–69	2912	33	23.3	40.4
Lower middle income	Egypt	2017	15–69	7200	63	53.8	74.1
Lower middle income	Papua New Guinea	2007–8	15–64	3000	32.1	30.3	33.9
Lower middle income	Viet Nam	2015	18–69	4320	13.9	13.2	4.7
Lower middle income	Uzbekistan	2014	18–64	4350	50.1	47.7	52.7
Lower middle income	Timor-Leste	2014	18–69	2710	11.2	8.2	16.7
Lower middle income	Bangladesh	2018	18–69	9900	20.3	15.8	25
Lower middle income	Congo	2004	24–64	2030	27.3	18	37.1
Lower middle income	Pakistan	2014	18–69	7669	41.3	38.6	43.2
Lower middle income	Sudan	2016	18–69	8145	28.2	22.6	35.6
Lower middle income	Cameroon	2003	15–64+	10,824	42.8	31.4	50.5
Lower middle income	Kenya	2015	18–69	6000	19	13.2	24.9
Lower middle income	Lesotho	2012	25–64	2310	41.5	24.8	58.2
Lower middle income	Myanmar	2014	25–64	9360	22.4	14.1	30.8
Lower middle income	Mauritania	2006	15–64	2600	46.6	31.8	59.4
Upper middle income	Thailand	2010	15–74	130,849	21.3	18.6	24
Upper middle income	Mauritius	2004	20–74	4500	25.4	25.1	25.7
Upper middle income	Nauru	2004	15–64	2500	82.2	82.1	82.2
Upper middle income	Malaysia	2005	25–64	3040	31.6	30.9	32.4
Upper middle income	Turkey	2017	15–69	8644	64.4	62.8	66
Upper middle income	Grenada	2010–11	25–64	1736	58.7	48.3	69.2
Upper middle income	Saint Lucia	2012	25–64	1834	65.6	53.9	77.1
Upper middle income	Maldives	2011	15–64	2000	37.1	32	42.3
Upper middle income	Saint Vincent and the Grenadines	2012	18–69	5180	54.2	41.3	67.2
Upper middle income	Botswana	2014	15–69	6400	18.8	14.7	23.2
Upper middle income	Lebanon	2016–17	18–69	5760	37.9	44.7	31.4
Upper middle income	Dominica	2007–8	15–64	1059	45.1	29.5	61.9
Upper middle income	Libya	2009	25–64	3590	63.5	57.5	69.8
Upper middle income	Belarus	2016–17	18–69	5760	60.6	61.5	60
Upper middle income	Iraq	2015	18–60+	4120	65.4	58.7	73.1
Upper middle income	Guatemala	2015	>18	2036	67.2	64	70.2
Upper middle income	Armenia	2016	18–69	2349	47.7	45.4	50.1
Upper middle income	Georgia	2016	18–69	5554	64.6	65.5	63.8
Upper middle income	American Samoa	2004	25–64	2188	93.5	92.7	94.4
Upper middle income	Sri Lanka	2015	18–69	7200	23.4	21	26
High income	Bermuda	2014	>18	2656	74.6	79.1	69.6
High income	Qatar	2012	18–64	2880	70.1	71.8	68.3
High income	Cayman Islands	2012	25–64	2105	70.6	67.6	73.7
High income	Kuwait	2014	18–69	4391	77.2	78.4	76.1
High income	Brunei Darussalam	2015–16	18–69	3808	62.8	63.2	62.5
High income	British Virgin Islands	2009	25–64	1802	39.2	45	32.2
High income	Aruba	2006	25–64	1565	77.1	82.8	72.1
High income	Bahrain	2007	20–64	20,037	33.4	34.8	32
High income	Saint Kitts and Nevis	2008	25–64	2750	78.5	74.1	83
High income	Trinidad and Tobago	2011	15–64	3020	30	32.9	27.3
High income	Barbados	2007	25–64	1283	65.2	54.6	74.3
High income	Oman	2006	>20	1700	33.3	39.2	28.7

STEPS: STEPwise approach to NCD risk factor surveillance; BMI: Body Mass Index

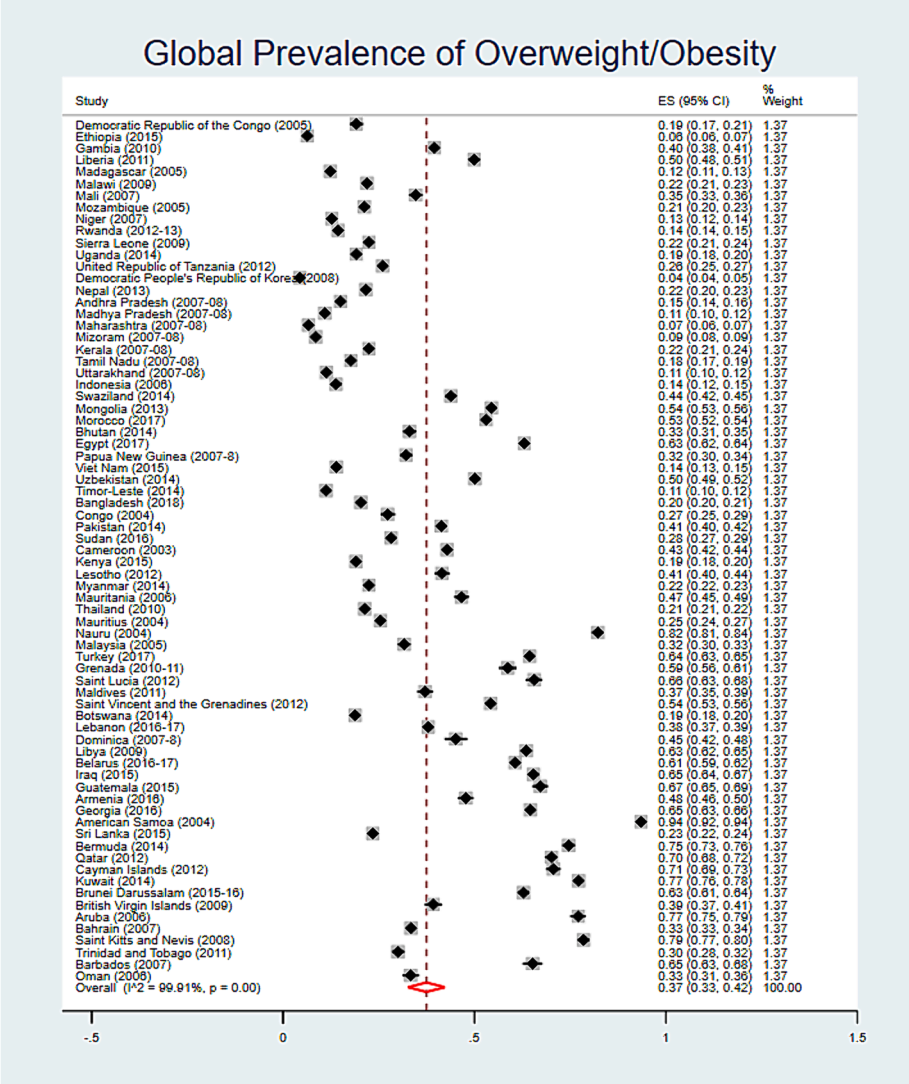


Fig. 2. Forest plot of the global prevalence of overweight/obese with 95% confidence intervals (CIs); ES: Effect Size (Prevalence of Overweight/Obesity).

et al., 2019; Kim and von dem Knesebeck, 2018; Templin et al., 2019).

This study also investigated the economic impacts of overweight/obesity using *meta*-regression analysis. The findings indicated that the global prevalence of overweight/obesity increased 14 % with one unit change in economic status which aligns with the existing literature (Specchia et al., 2015). A study of Bu and colleagues (2021) demonstrated a correlation between national economic development and body mass index (Bu et al., 2021). They observed a linear increase in BMI revealing a steady rise in BMI as well as overweight/obesity with economic development. Another study suggested that economic growth leads to rise of overweight/obesity (Seyda Seydel et al., 2016) and 1 % increase in income leads to around a 0.2–0.3 % higher in the prevalence of overweight/obesity (Ferretti and Mariani, 2017).

The health consequences of overweight/obese are enormous. Carrying extra fat in body leads to the serious health complexities including cardiovascular illness, diabetes, and various cancers which ultimately cause premature death and substantial disability (Kiwanuka, 2020; WHO, 2013). The Centers for Disease Control and Prevention (CDC) reported a list of serious diseases and health conditions including hypertension, high cholesterol, diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, difficulty with physical functioning, mental illness and many types of cancer caused by overweight/obesity (Centers for Disease Control and Prevention-CDC, 2022).

In this study, the evidence of small study effect was detected, which reported higher prevalence of overweight/obesity. The asymmetry of the funnel plot suggested the presence of publication bias among the selected studies. Controlling the high burden of overweight and obesity requires a multifaceted approach. Firstly, educating individuals about the importance of balanced diet and the dangers of consuming unhealthy foods is essential. Governments can also regulate the availability and marketing of unhealthy foods (Vardanjani et al., 2015). Secondly, regular physical activity is crucial for maintaining a healthy weight. Encouraging individuals to engage in exercise and other physical activities can help reduce the prevalence of overweight and obesity (Cox, 2017). Thirdly, healthcare services can play a critical role in controlling overweight and obesity. Health professionals can provide advice, support, and treatment to individuals struggling with these conditions (Pearce et al., 2019). Fourthly, creating supportive environments that make it easy for individuals to make healthy choices can be effective (Allender et al., 2012). This can include implementing policies that promote healthy eating and physical activity in schools, workplaces, and communities. Finally, Public awareness campaigns can help educate individuals about the risks of overweight and obesity and the importance of healthy lifestyles (Gill and Boylan, 2012; Walls et al., 2011). These campaigns can be implemented through various mass media channels, including social media, television, and Radio.

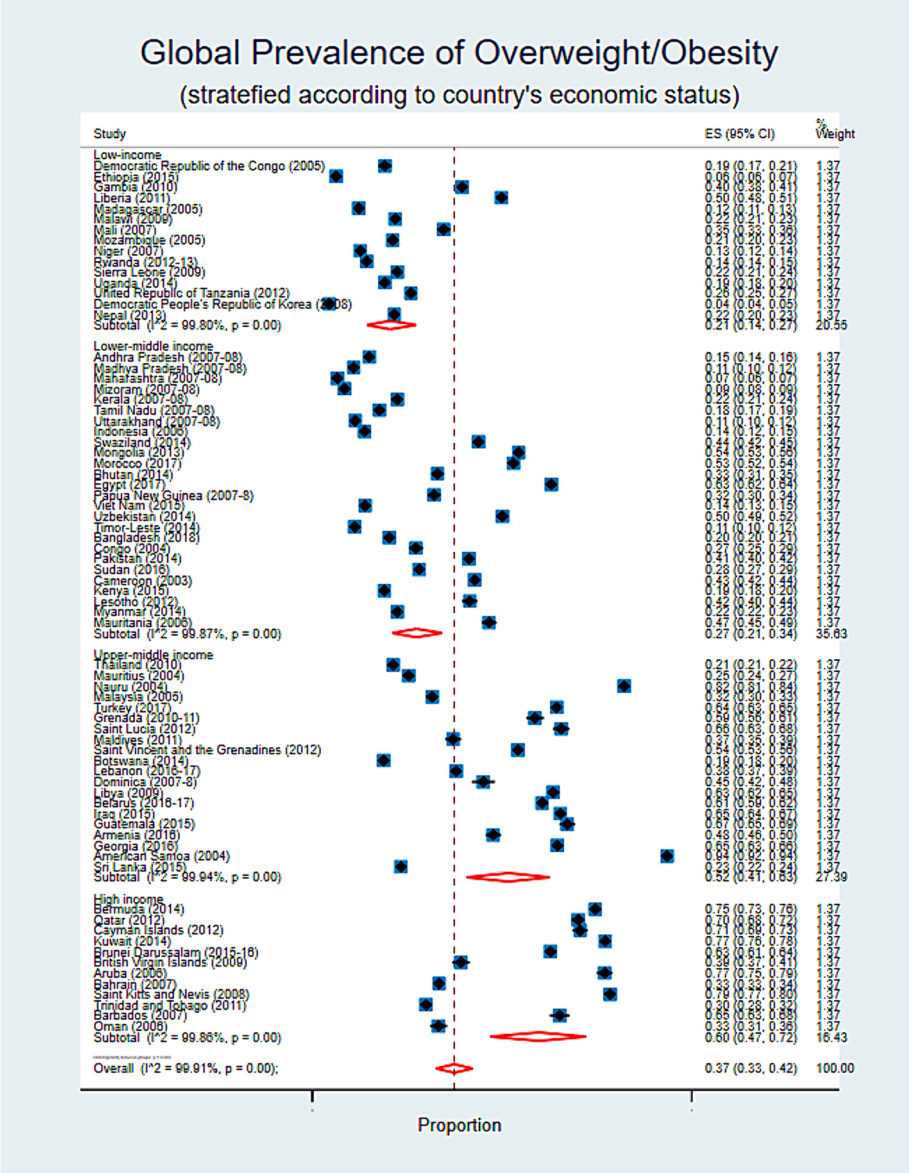


Fig. 3. Forest plot of the global prevalence of overweight/obese with 95% confidence intervals (CIs), stratified according to the country's economic status; ES: Effect Size (Prevalence of Overweight/Obesity).

5. Conclusion

This is the first comprehensive study that systematically evaluates the representative survey reports on the prevalence of overweight/obesity, extracting data from the STEPs surveys of WHO listed 73 member states. Considering the high observed heterogeneity among the included studies, our *meta*-analysis reports a globally high prevalence of overweight/obesity. The prevalence rate found comparatively high among the resident with upper economic status that may lead to 14 % increase chance of having overweight/obesity compared to low-income countries. NCDs is a key challenge for sustainable development where overweight/obesity the major NCD risk factor. As part of the action plan, WHO member states should take effective initiatives to control and prevent overweight/obesity as well as the risk factors of NCDs.

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CRediT authorship contribution statement

A.N.M. Shamsul Islam: . **Hafiza Sultana:** Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition. **Md. Nazmul Hassan Refat:** Writing – review & editing, Resources, Investigation, Funding acquisition. **Zaki Farhana:** Writing – review & editing, Writing – original draft, Visualization, Software, Formal analysis, Data curation. **Anton Abdulbasah Kamil:** Writing – review & editing, Writing – original draft, Resources, Funding acquisition. **Mohammad Meshbahur Rahman:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

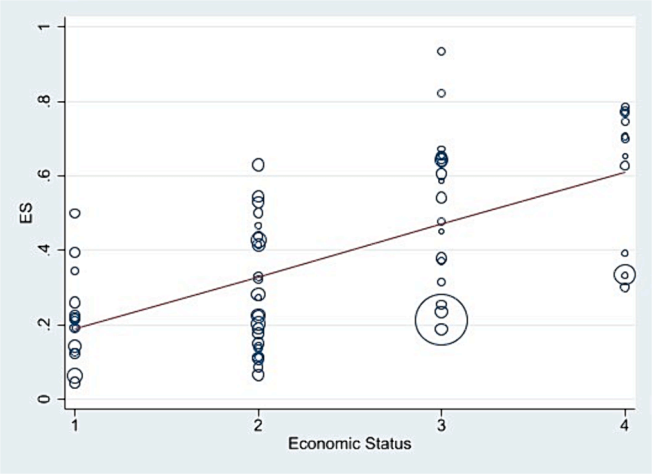


Fig. 4. Meta-regression of global overweight/obesity prevalence on countries economic status of the study participants; X-axis: ES- Effect Size (Prevalence of Overweight/Obesity); Y-axis: Economic Status of 73 countries involved in this study. The economic status 1 represent low-income countries; 2 means lower middle income c; 3 means upper middle income; and 4 means high income countries. The straight line represents the average line showing increasing rate of overweight/obesity prevalence with respect to the economic status of WHO member states.

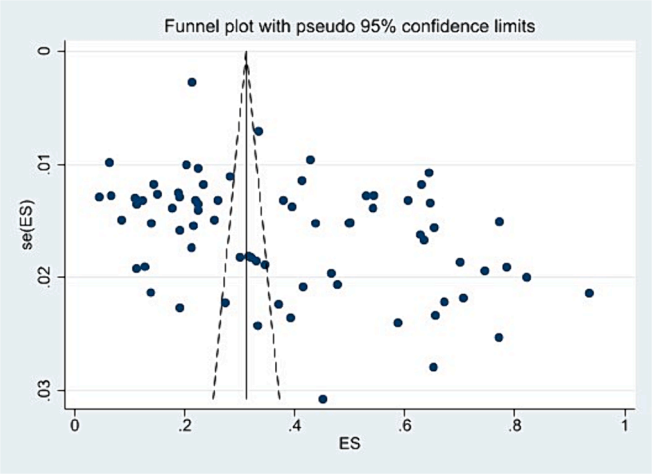


Fig. 5. Funnel plot of global overweight/obesity prevalence on countries economic status; X-axis: ES- Effect Size (Prevalence of Overweight/Obesity); Y-axis: se (ES)- standard error of effect size (Prevalence of Overweight/Obesity). In the graph, the black dots are the standard error of prevalence of overweight/obesity. The straight line is the average standard error and the dash lines are the confidence interval that indicates the presence of asymmetry and publication bias among the prevalence.

Data availability

All data involved in this study are provided in the full-text manuscript.

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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data are provided in the tables presented in the full-text.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102882.

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