ORIGINAL ARTICLE

Relation between obesity prevalence and the human development index and its components: an updated study on the Asian population

Zaher Khazaei[1] · Malihe Sohrabivafa[2] · Isan Darvishi[3] · Hasan Naemi[4] · Elham Goodarzi[5]

Abstract

Aim Obesity is a public health problem, and all high-, low- and middle-income countries face it worldwide. The purpose of this study was to investigate the epidemiology of obesity and its relation to the Human Development Index in Asian countries in 2016.
Subjects and methods This is an ecological study. The data required were the HDI and the prevalence of obesity (BMI $\geq$ 30) in adults > 18 years of age, obtained from the World Bank (https://data.worldbank.org/). Two-way correlation and analysis of variance were used at a significance level < 0.05, and the analyses were performed using Stata-14 software.
Results Between 2000 and 2016, the highest prevalence of obesity was found for males and females > 18 years living in the American and the lowest was found for those in Southeast Asia. The results showed that there was a positive and significant correlation between the prevalence of obesity in males (r = 0.486, $P < 0.001$) and females (r = 0.360, $P < 0.001$) with the HDI. The study of HDI components showed that there was a positive and significant correlation between the prevalence of obesity with GNI (r = 0.429, $P < 0.01$), MYS (r = 0.343, $P < 0.01$), LEB (r = 0.332, $P < 0.001$) and EYS (r = 0.331, $P < 0.001$). However, the correlation was not significant for the prevalence of obesity with GNI, MYS, LEB and EYS ($P > 0.05$). The highest mean prevalence of obesity in males (20.6 ± 11.8) and in females (26.3 ± 16.2) was linked to a very high human development index.
Conclusion According to the results, the prevalence of obesity among males and females in the Asian continent is higher in countries with a high HDI, indicating the presence of obesity-related factors in these countries. Therefore, attention to lifestyle and physical activity as risk factors for obesity can be effective in reducing the prevalence of obesity in these countries.

Keywords Obesity · Prevalence · Human development index · Asia

Introduction

Non-communicable diseases (NCDs) are a global health problem and a threat to the health and development of countries.

✉ Elham Goodarzi
elhamgoodarzi.1370@yahoo.com

1 Department of Epidemiology, School of Public Health, Ilam University of Medical Sciences, Ilam, Iran

2 School of Medicine, Dezful University of Medical Sciences, Dezful, Iran

3 Department Of Operating Room, Instructor Of Operating Room, Shahrekord University Of Medical Sciences, Shahrekord, Iran

4 Iranian Research Center on Healthy Aging, Sabzevar University of Medical Sciences, Sabzevar, Iran

5 Social Determinants of Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran

Increased life expectancy and rapid population growth have increased the burden of non-communicable disease. Major risk factors for chronic non-communicable diseases in most countries include hypertension, diabetes, obesity, high blood lipids, smoking, inadequate nutrition and not getting enough physical activity (Boutayeb, et al. 2013; Correa, et al. 2016).

The obesity epidemic is one of the growing public health concerns around the world. The prevalence of obesity worldwide has almost tripled in the last 4 decades. As a result, obesity has become a global epidemic that is still increasing in developed and developing countries (World Health Organization, 2018).

The prevalence of obesity is modifiable by changing metabolic rate, appetite, diet and physical activity. Although these factors are influenced by genetic traits, they are often associated with environmental changes (Marck et al., 2016). Obesity increases the risk of diseases, especially cardiovascular disease, endocrine and metabolic disorders, insulin-dependent

diabetes, psychological problems, sleep apnea, osteoarthritis and certain types of cancer (Marck et al. 2016; Ng et al. 2014).

In a systematic analysis of population-based studies, overweight and obesity in males increased from 28.8% in 1980 to 36.9% in 2013 and in females from 29.8% to 38.0% (Ng et al. 2014). In 2016, > 1.9 billion adults, 18 years and older, were overweight, of whom > 650 million were obese (Barich, et al. 2018).

Studies show that socioeconomic status (SES), education, occupation and income in developed and developing countries are factors associated with being overweight and obese (Dinsa et al. 2012). A systematic review by Dinsa et al. (2012) showed that there is a positive relationship between obesity and the HDI (Dinsa, et al. 2012). The difference between developed and developing countries in terms of economic, social and demographic indicators is enormous. Therefore, the aim of this study was to investigate the epidemiology of obesity prevalence and its relationship with the HDI in Asian countries.

Materials and methods

This is an ecological study examining the relationship between obesity (BMI ≥ 30) in females and males > 18 years of age and its relation to the development index in Asian countries. The data required in this study included the HDI and the prevalence of obesity in males and females from 2000 to 2016, which we obtained from the World Bank.

The HDI provided by the World Bank offers the most up-to-date information on global development and includes national, regional and global estimates. In the Human Development Report, countries are divided into groups of countries with high, medium and low human development. The numerical value of the HDI is between zero and one. The HDI figure shows how much each country has gone through to achieve the highest possible value, i.e., one. The index also allows for comparisons between countries. The HDI is a summary of human development measures. It measures the mean achievement of a country in three main dimensions of human development: long and healthy life, access to knowledge and living standards (Anand and Sen 1994).

Body mass index (BMI)

Body mass index was calculated from self-reported height and weight (kg/m²). BMI categories were calculated in accordance with World Health Organization guidelines: underweight (< 18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²) and obese (≥ 30 kg/m²) (Obesity, 2000).

Table 1 Prevalence of obesity among adults, BMI ≥ 30, age-standardized estimates by WHO region

WHO region	2016 — Prevalence of obesity among adults, BMI ≥ 30 Age - standardized estimated) — 18 + Years			2015 — Prevalence of obesity among adults, BMI ≥ 30 Age - standardized estimated — 18 + Years			2014 — Prevalence of obesity among adults, BMI ≥ 30 Age - standardized estimated) — 18 + Years		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
Africa	10.6 [9.6–11.7]	5.6 [4.5–6.8]	15.3 [13.6–17.1]	10.3 [9.3–11.3]	5.3 [4.4–6.4]	14.9 [13.4–16.5]	9.9 [9.1–10.9]	5.1 [4.2–6.1]	14.5 [13.1–16.0]
America	28.6 [26.6–30.5]	25.9 [23.2–28.8]	31.0 [28.2–33.7]	28.0 [26.2–29.8]	25.4 [22.8–28.0]	30.5 [27.9–33.1]	27.5 [25.8–29.2]	24.8 [22.4–27.3]	30.0 [27.5–32.4]
Southeast Asia	4.7 [3.9–5.6]	3.3 [2.4–4.3]	6.1 [4.9–7.6]	4.4 [3.7–5.2]	3.1 [2.3–4.0]	4.2 [3.6–4.9]	2.9 [2.2–3.7]	5.6 [4.5–6.8]	23.8 [21.8–25.8]
Europe	23.3 [21.7–24.9]	21.9 [19.8–24.1]	24.5 [22.2–26.7]	22.9 [21.4–24.3]	21.4 [19.4–23.4]	24.1 [22.0–26.3]	22.4 [21.1–23.8]	20.9 [19.0–22.8]	23.8 [21.8–25.8]
Eastern Mediterranean	20.8 [19.1–22.6]	15.7 [13.5–18.1]	26.0 [23.4–28.7]	20.3 [18.7–22.0]	15.2 [13.1–17.4]	25.5 [23.0–27.9]	19.6 [18.1–21.2]	14.7 [12.8–16.7]	24.9 [22.7–27.3]
Western Pacific	6.4 [5.2–7.7]	6.0 [4.4–8.0]	6.7 [5.1–8.7]	6.1 [5.0–7.3]	5.7 [4.2–7.4]	6.4 [5.0–8.2]	5.8 [4.8–6.8]	5.3 [4.0–6.9]	6.2 [4.9–7.8]
WHO(GLOBAL)	13.1 [12.4–13.9]	11.1 [10.2–12.2]	15.1 [14.0–16.2]	12.8 [12.1–13.5]	10.8 [9.9–11.7]	14.7 [13.8–15.7]	12.5 [11.8–13.1]	10.8 [9.7–12.0]	14.9 [13.6–16.1]

Female

Male

Prevalence (%)
- <10.0
- 10.0–19.9
- 20.0–29.9
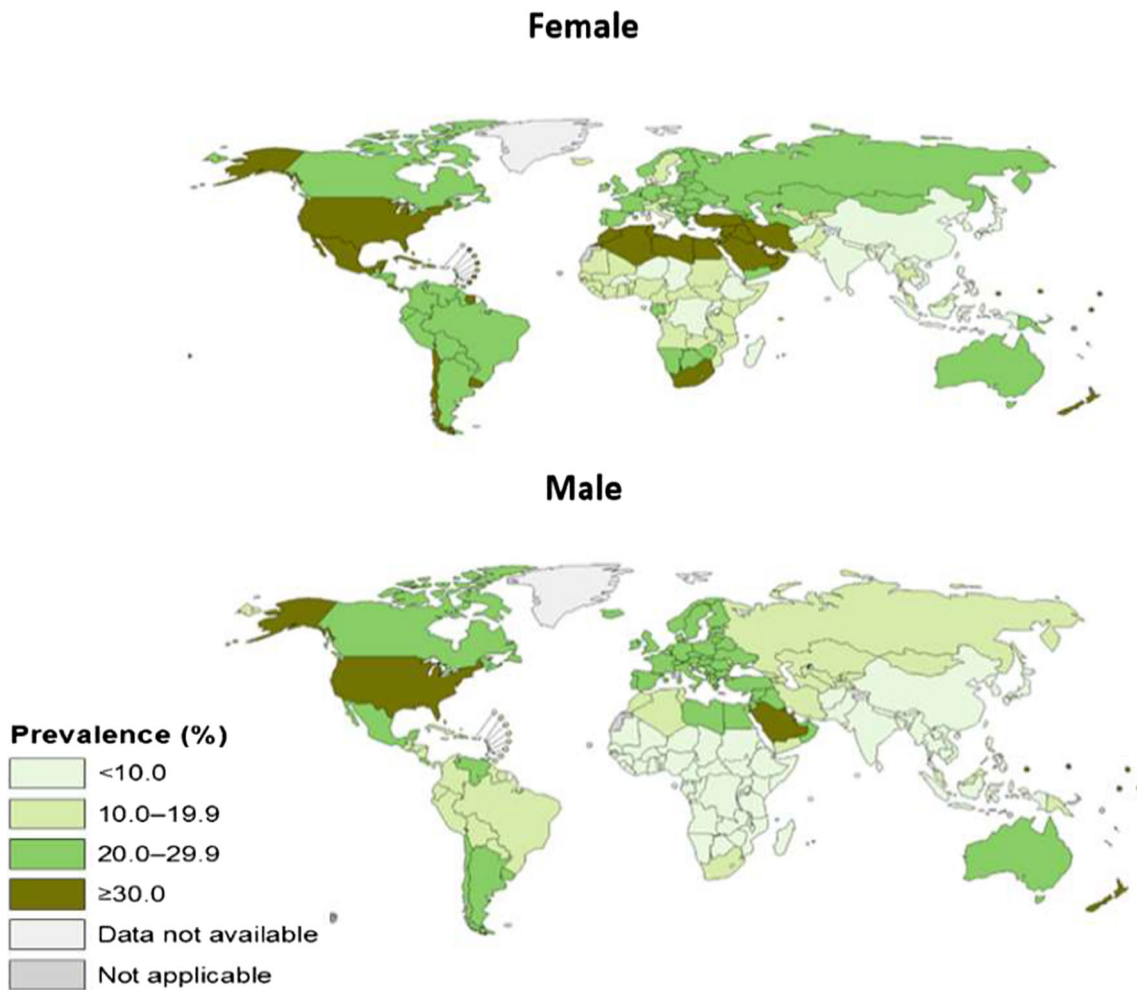- ≥30.0
- Data not available
- Not applicable

Fig. 1 Prevalence of obesity (BMI ≥ 30), age 18+ years, in females and males in 2016

Ethical considerations

Data recorded in this study are from the World Bank, and data on obesity in general are estimated for each country. Therefore, no specific ethical consideration was required. This article is the result of a research project approved by Kerman University of Medical Sciences Code of Ethics, IR.KMU.REC.1398.505.

Statistical analysis

Bivariate correlation analysis was used to analyze the correlation between the prevalence of obesity and HDI. Analysis of variance was used to investigate the relationship between obesity prevalence and HDI components. The significance level was < 0.05. Analyses were performed using Stata-14 software.

Fig. 2 Trend of obesity in both sexes by region, WHO results for 2000–2016
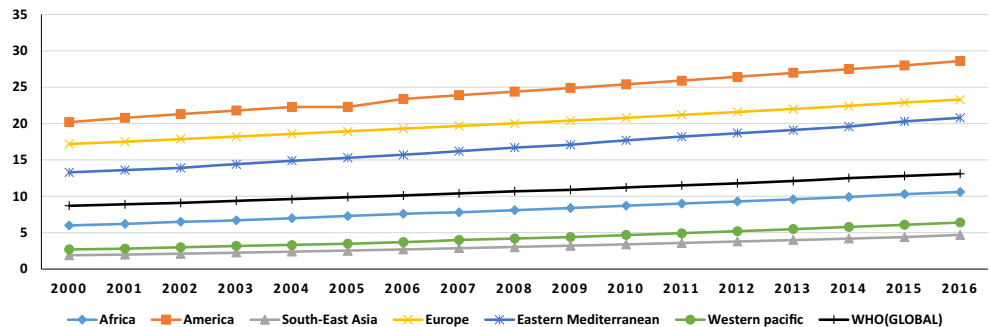
Table 2 Prevalence of obesity among adults, BMI ≥ 30, age-standardized estimates by Asian population during the years 2000–2016

Country	2016		2015		2010		2005		2000	
	18 + Years		18 + Years		18 + Years		18 + Years		18 + Years	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Afghanistan	3.2[1.3–6.4]	7.6[4.3–12.4]	3.0[1.3–6.0]	7.3[4.1–11.8]	2.2[1.0–4.4]	5.7[3.3–9.2]	1.6[0.7–3.3]	4.4[2.4–7.3]	1.2[0.4–2.5]	3.4[1.8–5.9]
Armenia	17.1[11.1–24.0]	23.0[16.6–29.9]	16.6[10.9–23.3]	22.6[16.4–29.1]	14.4[9.2–20.3]	20.4[15.0–26.1]	12.5[7.8–18.0]	18.4[13.5–23.9]	10.9[6.4–16.3]	16.8[12.0–22.2]
Azerbaijan	15.8[9.9–22.9]	23.6[16.7–31.0]	15.3[9.5–22.0]	23.0[16.5–30.2]	12.7[7.9–18.3]	20.1[14.6–26.3]	10.6[6.3–15.7]	17.6[12.7–23.4]	9.0[5.1–13.7]	15.6[10.8–21.0]
Bahrain	25.5[18.3–32.7]	36.8[29.2–44.6]	24.9[18.1–31.9]	36.4[29.1–43.9]	22.2[16.4–28.2]	34.3[28.1–40.6]	19.7[14.4–25.4]	32.4[26.8–38.3]	17.6[12.6–23.0]	30.7[25.1–36.5]
Bangladesh	2.3[1.1–4.0]	5.0[3.1–7.5]	2.1[1.0–3.7]	4.7[2.9–7.0]	1.5[0.7–2.5]	3.6[2.3–5.2]	1.0[0.5–1.8]	2.7[1.6–3.9]	0.7[0.3–1.3]	2.0[1.2–3.1]
Bhutan	4.7[2.3–8.2]	8.5[5.1–12.9]	4.4[2.2–7.7]	8.1[4.9–12.3]	3.2[1.6–5.6]	6.4[3.8–9.7]	2.3[1.1–4.1]	4.9[2.8–7.6]	1.5[0.7–2.9]	3.6[1.9–5.8]
Brunei	12.5[7.8–18.3]	15.7[10.6–21.8]	11.9[7.5–17.3]	15.3[10.3–21.0]	9.3[5.8–13.6]	13.0[8.8–17.9]	7.1[4.2–10.9]	10.9[7.5–15.5]	5.3[2.9–8.7]	9.1[5.7–13.4]
Cambodia	2.7[1.2–5.2]	4.8[2.8–7.5]	2.5[1.1–4.8]	4.6[2.7–7.0]	1.8[0.8–3.4]	3.5[2.1–5.3]	1.3[0.6–2.4]	2.6[1.5–4.1]	0.9[0.4–1.8]	2.0[1.1–3.2]
China	5.9[3.9–8.4]	6.5[4.5–9.1]	5.5[3.7–7.7]	6.2[4.4–8.5]	3.9[2.8–5.1]	5.0[3.8–6.4]	2.6[2.0–3.4]	3.8[3.0–4.8]	1.8[1.3–2.3]	2.9[2.3–3.7]
Cyprus	21.9[14.6–30.0]	21.6[15.0–29.1]	21.4[14.4–29.3]	21.4[14.9–28.6]	19.2[13.2–26.0]	20.2[14.3–26.5]	17.2[11.6–23.4]	19.1[13.6–25.0]	15.0[9.9–21.1]	17.7[12.4–23.6]
Georgia	19.2[13.1–26.3]	23.8[17.2–30.8]	18.5[12.6–25.4]	23.1[16.8–29.9]	15.5[10.5–21.5]	20[14.8–26.2]	13.6[8.6–19.3]	17.9[13.0–23.5]	11.1[6.8–16.8]	15.9[10.9–21.4]
India	2.7[1.7–4.0]	5.1[3.6–6.9]	2.6[1.7–3.7]	4.8[3.5–6.5]	1.9[1.3–2.5]	3.8[2.9–4.8]	1.3[1.0–1.8]	3.0[2.3–3.7]	1.0[0.7–1.3]	2.3[1.8–2.9]
Indonesia	4.8[3.2–6.8]	8.9[5.9–12.5]	4.5[3.1–6.4]	8.5[5.7–11.8]	3.1[1.9–4.6]	6.6[4.7–9.0]	2.1[1.3–3.1]	5.1[3.6–7.0]	1.3[0.8–2.1]	3.8[2.5–5.4]
Iran, Islamic Republic of	19.3[15.0–23.8]	32.2[27.2–37.4]	18.6[14.8–22.7]	31.7[27.0–36.4]	15.5[13.0–18.3]	28.7[25.4–32.1]	12.8[10.7–15.1]	25.8[22.9–28.8]	10.3[8.3–12.7]	23.0[19.9–26.3]
Iraq	23.4[17.0–30.4]	37.0[29.7–44.3]	22.8[16.7–29.4]	36.4[29.4–43.6]	19.7[14.4–25.4]	33.7[27.4–40.1]	17.2[12.1–22.5]	31.3[25.1–37.6]	15.0[10.1–20.3]	29.1[22.9–35.7]
Israel	25.9[19.0–33.2]	26.2[19.7–33.3]	25.4[18.9–32.3]	26.1[19.7–32.9]	23.1[17.8–29.0]	25.1[19.6–30.9]	21.0[16.1–26.4]	24.2[19.1–29.5]	18.8[14.1–24.3]	23.1[18.2–28.4]
Japan	4.8[3.2–6.8]	3.7[2.5–5.2]	4.6[3.1–6.4]	3.6[2.5–5.0]	3.5[2.6–4.6]	3.1[2.3–4.1]	2.5[1.9–3.3]	2.6[2.0–3.3]	1.9[1.1–2.4]	2.2[1.8–2.8]
Jordan	28.2[21.9–34.5]	43.1[36.9–49.3]	27.5[21.6–33.6]	42.5[36.7–48.5]	24.2[19.4–29.5]	40.0[35.0–44.9]	21.2[16.9–26.1]	37.4[32.9–42.1]	18.5[14.2–23.4]	34.9[30.2–39.8]
Kazakhstan	18.9[13.1–25.6]	22.7[17.0–28.9]	18.3[12.7–24.8]	22.1[16.7–28.2]	15.7[10.8–21.6]	19.7[15.0–25.0]	13.6[8.9–19.2]	17.6[13.1–22.8]	11.7[7.1–17.2]	15.7[11.3–20.9]
Korea, Republic of	6.1[2.9–10.8]	7.3[3.6–12.2]	5.8[2.7–10.3]	7.0[3.4–11.4]	4.7[2.2–8.3]	6.2[3.2–10.3]	3.7[1.7–6.8]	5.5[2.8–9.1]	3.0[1.3–5.6]	4.8[2.4–8.2]
Kuwait	33.3[27.0–39.7]	45.6[39.1–52.1]	32.6[26.6–38.7]	45.2[39.0–51.4]	29.5[24.8–34.3]	43.2[38.1–48.3]	26.7[22.3–31.2]	41.3[36.5–46.2]	24.1[19.8–28.8]	39.5[34.6–44.7]
Kyrgyzstan	14.0[8.3–21.0]	18.6[13.0–25.1]	13.5[8.1–20.1]	18.1[12.6–24.2]	11.1[6.7–16.5]	15.4[10.8–20.6]	9.2[5.3–14.0]	13.1[9.1–17.8]	7.6[4.2–12.2]	11.3[7.5–15.9]
Lao People's Democratic Republic	3.7[1.9–6.5]	6.7[4.0–10.3]	3.4[1.8–5.9]	6.3[3.8–9.7]	2.2[1.1–3.8]	4.7[2.8–7.3]	1.4[0.7–2.5]	3.4[2.0–5.4]	0.9[0.4–1.6]	2.4[1.3–4.1]
Lebanon	27.4[20.2–35.0]	37.0[29.7–44.8]	26.8[19.9–34.1]	36.5[29.6–44.1]	23.8[18.0–29.9]	34.3[28.2–40.9]	21.1[15.7–26.7]	32.2[26.3–38.4]	18.6[13.4–24.2]	30.1[24.3–36.3]
Malaysia	13.0[9.2–17.6]	17.9[13.5–23.0]	12.3[8.8–16.6]	17.4[13.2–22.0]	9.4[6.9–12.4]	14.5[11.3–18.2]	6.9[4.9–9.3]	11.9[9.0–15.1]	4.8[3.1–6.9]	9.3[6.7–12.4]
Maldives	5.8[3.2–9.7]	11.4[7.4–16.6]	5.4[3.0–9.0]	10.8[7.0–15.7]	3.6[2.0–6.0]	8.3[5.5–12.0]	2.3[1.2–4.0]	6.1[3.9–9.2]	1.5[0.7–2.8]	9.3[6.7–12.4]
Mongolia	17.5[11.9–23.9]	23.2[17.0–29.7]	16.8[11.4–22.9]	22.6[16.8–28.7]	13.5[9.3–18.5]	19.5[14.6–24.6]	10.6[7.1–15.1]	16.6[12.2–21.5]	8.6[5.3–12.8]	14.4[10.1–19.1]
Myanmar	4.0[2.2–6.6]	7.3[4.6–10.5]	3.8[2.1–6.1]	6.9[4.4–10.0]	2.6[1.5–4.2]	5.3[3.4–7.6]	1.8[1.0–3.0]	4.0[2.5–6.0]	1.2[0.6–2.2]	3.1[1.8–4.7]
Nepal	2.7[1.4–4.5]	5.4[3.4–8.0]	2.5[1.3–4.2]	5.1[3.2–7.5]	1.8[1.0–3.0]	3.9[2.6–5.6]	1.3[0.7–2.2]	3.0[1.9–4.3]	0.9[0.5–1.6]	2.2[1.3–3.3]
Oman	22.9[16.8–29.8]	33.7[26.4–41.1]	22.2[16.3–28.6]	33.1[26.1–40.2]	18.6[13.9–23.5]	29.9[24.0–35.7]	15.6[11.5–20.0]	27.1[21.8–32.4]	13.3[9.5–17.6]	24.7[19.6–30.0]
Pakistan	6.0[3.5–9.5]	11.3[7.6–15.7]	5.7[3.3–8.9]	10.8[7.3–15.0]	4.3[2.5–6.6]	8.7[6.1–12.1]	3.2[1.9–5.0]	7.0[4.8–9.8]	2.4[1.4–3.9]	5.6[3.7–8.1]
Philippines	5.2[2.9–8.4]	7.5[4.8–11.0]	5.0[2.8–7.9]	7.2[4.7–10.4]	3.8[2.5–5.9]	6.0[4.1–8.3]	3.0[1.8–4.6]	5.0[3.5–6.9]	2.3[1.3–3.7]	4.2[2.9–5.8]
Qatar	32.5[25.0–40.2]	43.1[35.4–50.5]	31.8[24.7–39.1]	42.6[35.2–49.8]	28.3[22.3–34.8]	40.3[33.9–46.7]	25.2[19.6–31.3]	38.1[31.9–44.2]	22.3[16.7–28.4]	36.0[29.6–42.3]
Saudi Arabia	30.8[24.8–37.0]	42.3[35.8–48.6]	30.0[24.3–35.9]	41.7[35.6–47.7]	26.4[21.9–31.0]	39.1[34.3–43.8]	23.1[19.1–27.3]	36.5[32.2–40.9]	20.1[16.2–24.3]	34.0[29.7–38.4]
Singapore	5.8[3.4–9.3]	6.3[3.9–9.6]	5.6[3.3–8.9]	6.3[3.9–9.4]	4.8[3.0–7.2]	5.9[3.9–8.5]	4.1[2.5–6.0]	5.6[3.7–7.9]	3.4[2.0–5.3]	5.3[3.5–7.6]
Sri Lanka	2.9[1.5–5.0]	7.3[4.5–10.9]	2.7[1.4–4.6]	6.9[4.3–10.3]	1.9[1.0–3.2]	5.4[3.5–7.9]	1.3[0.7–2.3]	4.2[2.6–6.3]	0.9[0.5–1.7]	3.2[1.9–5.1]
Syrian Arab Republic	20.9[14.1–28.6]	34.8[26.4–43.2]	20.2[13.7–27.5]	34.1[26.4–42.3]	16.9[11.6–23.1]	30.8[24.0–37.9]	14.1[9.4–19.6]	27.7[21.3–34.4]	11.7[7.4–16.7]	24.8[18.6–31.4]
Tajikistan	11.6[6.7–17.9]	16.7[11.3–22.8]	11.1[6.4–17.2]	16.1[11.0–22.0]	9.0[5.2–14.2]	13.5[9.2–18.7]	7.4[4.0–12.0]	11.4[7.5–16.1]	6.1[3.1–10.6]	9.7[6.2–14.4]
Thailand	7.0[4.2–10.8]	12.7[8.7–17.6]	6.5[3.9–10.0]	12.1[8.4–16.6]	4.4[2.7–6.6]	9.3[6.7–12.6]	2.9[1.8–4.4]	7.0[4.9–9.5]	2.0[1.1–3.1]	5.3[3.6–7.4]
Timor-Leste	2.6[1.2–4.8]	4.9[2.8–7.9]	2.4[1.1–4.5]	4.6[2.6–7.4]	1.7[0.8–3.0]	3.5[2.0–5.6]	1.1[0.5–2.1]	2.6[1.4–4.3]	0.8[0.3–1.5]	2.0[1.0–3.3]
Turkey	24.4[19.2–29.8]	39.2[33.7–45.0]	23.6[18.9–28.7]	38.6[33.4–44.0]	20.2[16.7–24.0]	35.4[31.4–39.5]	17.1[14.1–20.3]	32.2[28.6–35.9]	14.4[11.4–17.6]	29.2[25.6–33.0]
Turkmenistan	15.9[10.0–23.0]	20.9[14.6–28.0]	15.3[9.6–22.2]	20.3[14.3–27.0]	12.7[7.9–18.5]	17.5[12.4–23.5]	10.5[6.2–15.9]	15.1[10.4–20.5]	8.6[4.8–13.7]	13.0[8.6–18.3]
United Arab Emirates	27.5[20.3–35.0]	41.0[33.7–48.8]	26.8[19.9–34.0]	40.5[33.4–48.0]	23.5[17.8–29.7]	37.9[31.6–44.2]	20.4[15.2–26.1]	35.2[29.2–41.0]	17.7[12.8–23.1]	32.7[26.9–38.4]
Uzbekistan	13.8[8.4–20.3]	19.0[13.0–25.6]	13.3[8.2–19.5]	18.4[12.7–24.7]	11.0[6.8–16.2]	15.7[11.0–21.0]	9.1[5.4–13.9]	13.5[9.2–18.2]	7.6[4.3–12.1]	11.6[7.7–16.2]
Vietnam	1.6[0.8–2.8]	2.6[1.5–4.2]	1.5[0.8–2.5]	2.4[1.4–3.9]	0.9[0.5–1.5]	1.7[1.0–2.7]	0.6[0.3–0.9]	1.2[0.7–1.9]	0.4[0.2–0.6]	0.9[0.5–1.4]
Yemen	12.0[7.3–17.6]	22.0[16.0–28.4]	11.4[7.0–16.7]	21.3[15.6–27.4]	8.8[5.5–12.7]	18.0[13.4–22.9]	6.7[4.1–10.1]	15.1[11.0–19.5]	5.1[2.9–8.0]	12.5[8.7–16.7]

Fig. 3 Correlation between the Human Development Index and prevalence of obesity in Asia in 2016

R Sq. linear=0.360, P<0.001

R Sq. linear=0.486, P<0.001
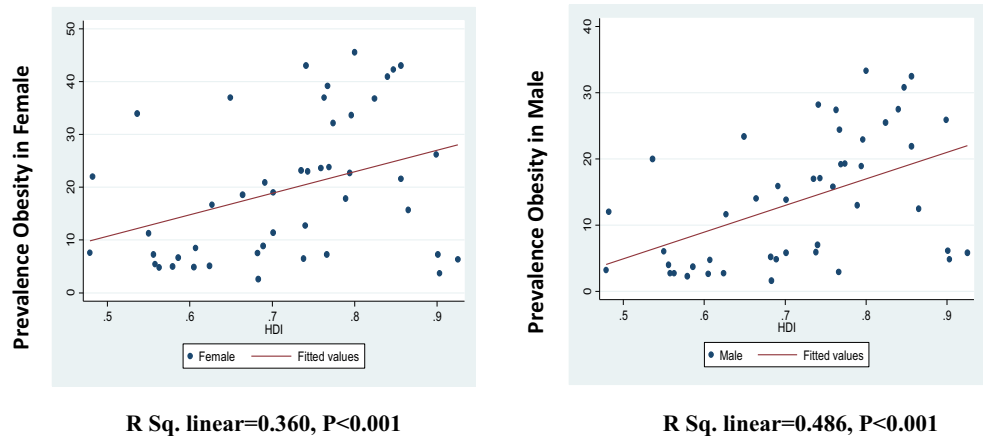
Results

The results of the study showed that in 2016 the highest prevalence of obesity in males (25.9 [23.2–28.8]) and females (31.0 [28.2–33.7]) was found for the USA (Table 1, Fig. 1). The highest prevalence of obesity was obtained for males and females > 18 years between 2000 and 2016 in the American and the lowest was found for Southeast Asia. The trend to obesity has been increasing worldwide (Fig. 2).

The results revealed that the highest rates for the prevalence of obesity in males are for Kuwait (33.3 [27.0–39.7]), Qatar (32.5 [25.0–40.2]) and Saudi Arabia (30.8 [24.8–37.0]), respectively.

The highest rates for the prevalence of obesity in females are for Kuwait (45.6 [39.1–52.1]), Qatar ([35.4–50.5]) and Jordan (43.1 [36.9–49.3]), respectively (Table 2).

The results showed that there was a positive and significant correlation between the prevalence of obesity in males ($r = 0.486$, $P < 0.001$) and females ($r = 0.360$, $P < 0.001$) with the HDI (Fig. 3).

The study of HDI components showed that there was a positive and significant correlation between the prevalence of obesity in males with GNI ($r = 0.429$, $P < 0.01$), MYS ($r = 0.343$, $P < 0.01$), LEB ($r = 0.332$, $P < 0.001$) and EYS ($r = 0.331$, $P < 0.001$). However, the correlation was not significant for the prevalence of obesity in females with GNI, MYS, LEB and EYS ($P > 0.05$) (Table 3).

Analysis of variance showed that in males the highest mean prevalence of obesity (20.6 ± 11.8) was related to very high human development and the lowest mean prevalence (6.7 6. 6.2) was related to medium human development, and this difference was statistically significant ($F = 4.73$, $P < 0.001$). In females, the highest mean prevalence of obesity (26.3 ± 16.2) was associated with very high human development and the lowest mean prevalence (8.8 10. 10.7) was associated with medium human development and was statistically significant ($F = 4.11$, $P < 0.001$) (Table 4).

Discussion

Obesity is one of the biggest public health problems of all age groups and socioeconomic statuses worldwide. Nutrition-related illnesses are still an important issue; now unhealthy eating patterns such as overweight and obesity have become a major concern. Thus, in countries undergoing socioeconomic changes, there is a shift in socioeconomic structures, which emphasizes the need to identify risk factors associated with unhealthy nutrition. Socioeconomic status may indirectly affect overweight and obesity through dietary habits, access to sports, health literacy and exercise (Fillol, et al. 2011; Mesters, et al. 2014; Pigeyre, et al. 2016; Saito, et al. 2013).

Table 3 Prevalence of obesity (BMI ≥ 30) in different HDI regions in males and females in 2016

Indicators	Prevalence of obesity among males		Prevalence of obesity among females	
	r*	P value	r*	P value
Gross national income per 1000 capita	0.429	< 0.01	0.346	< 0.001
Mean years of schooling	0.343	< 0.01	0.222	> 0.05
Life expectancy at birth	0.332	< 0.01	0.224	> 0.05
Expected years of schooling	0.331	< 0.01	0.216	> 0.05

*Statistical method used: Pearson correlation coefficient (r)

Table 4 Pearson correlation between the HDI component and the dependent variable

HDI	Prevalence of obesity among males Mean ± SD	Prevalence of obesity among females Mean ± SD
Very high human development	20.6 ± 11.8	26.3 ± 16.2
High human development	16.1 ± 7.7	23.5 ± 11.1
Medium human development	6.7 ± 6.2	10.7 ± 8.8
Low human development	11.7 ± 8.4	21.2 ± 13.2
P value (F-test)*	*P* < 0.001	*P* < 0.001

*Statistical method used: analysis of variance (ANOVA)

The results of our study showed the highest prevalence of obesity in males and females is in the American and the lowest in Southeast Asia. The results showed that there was a positive and significant correlation between the prevalence of obesity in males (R = 0.486, $P < 0.001$) and females (R = 0.360, $P < 0.001$) with the HDI. Examination of the relation between HDI components with obesity prevalence showed a significant positive correlation between obesity prevalence in males with GNI (r = 0.429, $P < 0.01$), MYS (r = 0.343, $P < 0.01$), LEB (r = 0.332, $P < 0.001$) and EYS (r = 0.331, $P < 0.001$). The highest mean prevalence of obesity for males (20.6 ± 11.8) and females (26.3 ± 16.2) was linked to a very high human development index.

The prevalence of obesity and overweight varies across the world. In European countries, about 32 to 45% of the population is overweight and 11–20% is obese. Eastern European countries (e.g., Hungary, the Czech Republic, Lithuania and Slovenia) have the highest overweight and obesity rates. To some extent, changes in the prevalence of overweight and obesity may be due to differences in lifestyle and physical inactivity (Blundell et al. 2017; Kohl et al. 2012; Lee et al. 2012).

Women with a higher socioeconomic status are less likely to be obese throughout their lives, while this finding is less consistent for men. One possible reason for the difference is that females with a higher socioeconomic status may better understand and control the factors associated with weight gain and obesity, whereas males with lower socioeconomic status may have higher levels of physical activity and be more likely to engage in hard, high-mobility jobs (Chang and Lauderdale 2005; Jeffery and French 1996; Lee et al. 2009).

About two-thirds of females in the Middle East and North Africa and half the females in Central and South America and the Caribbean are overweight or obese. In response to the growing number of overweight and obese populations throughout Latin America, the Pan American Health Organization (PAHO) specifically targets obesity and its association with socioeconomic levels (Mitchell and Shaw 2015).

So far, the obesity epidemic has been the most prevalent in urban areas, but the prevalence of obesity has also increased with increasing development in rural areas. Obesity is more common in LMICs than in females of higher socioeconomic backgrounds (Prentice 2005).

Fast-food consumption in developed countries was initially more common in people with higher socioeconomic status, but later, lower socioeconomic groups increased their consumption of fast food because of lower costs. In addition, cultural issues and norms in some countries related to overweight and obesity are associated with wealth, power and higher education for males and females (Prentice 2005). Literacy, especially related to diet-related behaviors and physical activity and healthy living programs, is a measure needed to prevent obesity (Marques et al. 2017).

Conclusion

According to the results, the prevalence of obesity among males and females in the Asian continent is higher in countries with high HDIs, indicating the presence of obesity-related factors in these countries. Therefore, considering lifestyle modification and daily physical activity, avoiding a high calorie diet as a modifiable risk factor can be effective in reducing the prevalence of obesity in these countries.

Compliance with ethical standards

Conflict of interest The authors report no conflict of interest.

References

Anand S, Sen A (1994) Human Development Index: Methodology and Measurement. pp182

Barich F, Zahrou FE, Laamiri FZ, El Mir N, Rjimati M, Barkat A, Aguenaou H (2018) Association of obesity and socioeconomic status among women of childbearing age living in urban area of Morocco. J Nutr Metab 20(18):312. https://doi.org/10.1155/2018/6043042

Blundell JE, Baker JL, Boyland E, Blaak E, Charzewska J, De Henauw S, Holm L (2017) Variations in the prevalence of obesity among European countries, and a consideration of possible causes. Obes Facts 10(1):25–37. https://doi.org/10.1159/000455952

Boutayeb A, Boutayeb S, Boutayeb W (2013) Multi-morbidity of non communicable diseases and equity in WHO eastern Mediterranean countries. Int J Equity Health 12(1):60

Chang VW, Lauderdale DS (2005) Income disparities in body mass index and obesity in the United States, 1971-2002. Arch Intern Med 165(18):2122–2128

Correa MM, Thume E, De Oliveira ERA, Tomasi E (2016) Performance of the waist-to-height ratio in identifying obesity and predicting non-communicable diseases in the elderly population: a systematic literature review. Arch Gerontol Geriatr 65(2):174–182. https://doi.org/10.1016/j.archger.2016.03.021

Dinsa GD, Goryakin Y, Fumagalli E, Suhrcke M (2012) Obesity and socioeconomic status in developing countries: a systematic review. Obes Rev 13(11):1067–1079. https://doi.org/10.1111/j.1467-789X.2012.01017.x

Fillol F, Dubuisson C, Lafay L, Dufour A, Bertin M, Touvier M, Lioret S (2011) Accounting for the multidimensional nature of the relationship between adult obesity and socio-economic status: the French Second National Individual Survey on Food Consumption (INCA 2) dietary survey (2006–07). Br J Nutr 6(10):1602–1608. https://doi.org/10.1017/S0007114511002030

Jeffery RW, French SA (1996) Socioeconomic status and weight control practices among 20-to 45-year-old women. Am J Public Health 86(7):1005–1010. https://doi.org/10.2105/AJPH.86.7.1005

Kohl HW 3rd, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, Group LPASW (2012) The pandemic of physical inactivity: global action for public health. Lancet 380(9838):294–305. https://doi.org/10.1016/S0140-6736(12)60898-8

Lee H, Harris KM, Gordon-Larsen P (2009) Life course perspectives on the links between poverty and obesity during the transition to young adulthood. Popul Res Policy Rev 28(4):505. https://doi.org/10.1007/s11113-008-9115-4

Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, Group LPASWs (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 380(9838):219–229. https://doi.org/10.1016/S0140-6736(12)61031-9

Marck CH, Neate SL, Taylor KL, Weiland TJ, Jelinek GA (2016) Prevalence of comorbidities, overweight and obesity in an international sample of people with multiple sclerosis and associations with modifiable lifestyle factors. PLoS One 11(3):e0148573. https://doi.org/10.1371/journal.pone.0148573

Marques A, Peralta M, Naia A, Loureiro N, de Matos MG (2017) Prevalence of adult overweight and obesity in 20 European countries, 2014. Eur J Pub Health 28(2):295–300. https://doi.org/10.1093/eurpub/ckx143

Mesters I, Wahl S, Van Keulen HM (2014) Socio-demographic, medical and social-cognitive correlates of physical activity behavior among older adults (45–70 years): a cross-sectional study. BMC Public Health 14(1):647. https://doi.org/10.1186/1471-2458-14-647

Mitchell S, Shaw D (2015) The worldwide epidemic of female obesity. Best Pract Res Clin Obstet Gynaecol 29(3):289–299

Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Abera SF (2014) Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the global burden of disease study 2013. Lancet 384(9945):766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

Obesity W (2000) Preventing and Managing the Global Epidemic. Report of a WHO consultation. Geneva: World Health Organization (3):358

Pigeyre M, Rousseaux J, Trouiller P, Dumont J, Goumidi L, Bonte D, Amouyel P (2016) How obesity relates to socio-economic status: identification of eating behavior mediators. Int J Obes 40(11):1794. https://doi.org/10.1038/ijo.2016.109

Prentice AM (2005) The emerging epidemic of obesity in developing countries. Int J Epidemiol 35(1):93–99. https://doi.org/10.1093/ije/dyi272

Saito Y, Oguma Y, Inoue S, Tanaka A, Kobori Y (2013) Environmental and individual correlates of various types of physical activity among community-dwelling middle-aged and elderly Japanese. Int J Environ Res Public Health 10(5):2028–2042. https://doi.org/10.3390/ijerph10052028

World Health Organization, O. a. O. World Health Organization, Geneva, Switzerland, 2018. http://www.who.int/mediacentre/factsheets/fs311/en/