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Obesity prevalence in adults and patients with hepatitis C: results from screening a population of 50 million in Egypt

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Abstract

Obesity is a global health problem and has been increasing in Egypt over the last several decades. A national population screening program for hepatitis C included screening for obesity. Here we report the outcome of body mass index (BMI) calculation for the screened population and for patients with hepatitis C.

Methods Adults 18 years and older (a target population of 62.5 million) were invited to participate in a screening program between October 2018 and April 2019. Persons had their BMI calculated. All data were entered in real-time to a central database via cellular networks. BMI data for patients with hepatitis C virus (HCV) infection before starting direct antiviral therapy were obtained from the National Committee for the Control of Viral Hepatitis (NCCVH)

Findings 49.6 million persons (25.6 million females and 24.0 million males) voluntarily participated and had valid height and weight data. 12.7 million females (49.51%) and 7.09 million males (29.53%) were affected by obesity (BMI ≥ 30kg/m^2). Obesity increased with age, was more prevalent in females, was more prevalent in the Nile Delta states and in urban areas. Detailed district-level prevalence for the whole country is identified. Prevalence of obesity among 335,504 patients with HCV was higher in females, increased with age, and was significantly lower overall and in males and females than in the screened general population.

Conclusion This is the largest population screening program for obesity. We show that obesity prevalence in the general population is currently among the highest in the world, starting in young adults, and highlight the high prevalence areas. Prevalence is lower in patients with HCV.

Keywords Obesity, Body mass index, Egypt, Prevalence, Screening, Hepatitis C

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Introduction

Obesity is a major health problem, increasing the risk of many diseases including fatty liver disease, type 2 diabetes mellitus, cardiovascular, cerebrovascular, musculoskeletal disorders, Alzheimer's disease, some cancers, and all-cause mortality [1–3]. Obesity is also a cause of poor quality of life in some instances, due to discrimination, stigmatization, and impact on employment chances. Currently, the World Obesity Federation views obesity as a chronic progressive disease, and not just a risk factor for other diseases [4].

Obesity is increasing globally. The World Health Organization (WHO) estimates that the global prevalence of obesity has tripled between 1975 and 2017 [5]. In Egypt, the prevalence of obesity has been increasing. However, all previous data on obesity prevalence in Egypt [6–18] included relatively small sample sizes (the 2017 WHO's STEPwise approach to surveillance of non-communicable diseases (STEPS) survey included 6670 persons [15], the 2014 Demographic and Health Survey (DHS) included 19,021 adult females [17] and the 2015 Health Issues Survey included body mass index (BMI) data for 15,602 adult males and females [16]). In the last quarter of 2018, Egypt embarked on the largest population disease screening campaign in history, aiming at identifying and treating patients infected with the hepatitis C virus (HCV). Over 7 months in 2018 and 2019, 49.6 million persons were screened for HCV antibodies [19]. During the same screening, persons also had their height and weight checked and body mass index (BMI) calculated. They also had their blood glucose and blood pressure measured.

Here we present the details of the BMI calculation for 49,630,319 Egyptian adults and compare it to the BMI data of 335,504 patients with HCV infection.

Methods

The details of the national health and HCV screening campaign in Egypt have been described previously [19, 20]. In brief, goals were set to screen the entire population 18 years of age or older (a target population of 62.5 million) for hepatitis C and to provide treatment to all those with HCV viremia, with the screening and treatment paid for by the state. In addition, all persons participating in screening had their height and weight recorded to calculate their body mass index (BMI) as part of screening for some non-communicable diseases (NCDs). They also had their blood glucose and blood pressure checked. Results of HCV serostatus, BMI, blood glucose level, and blood pressure were recorded on a paper card given to the person for her/his records and entered electronically into a central database via computers or handheld devices via cellular networks.

Participation in screening was voluntary. Persons seropositive for HCV were referred for evaluation and treatment as described previously [19]. Persons with elevated blood glucose or blood pressure were referred to the closest general hospital for evaluation and management, and persons with a BMI over 30 kg/m^2 were counseled about lifestyle modification and the need to lose weight.

Detailed population data for 2019 for the analysis of the screening data were obtained from the Central Agency for Public Mobilization and Statistics (CAPMAS) (the National Statistical Agency of Egypt), and the 2022 population to calculate current prevalence was obtained from CAPMAS report of October 2022 [21].

Overweight/obese is defined as a BMI of 25 kg/m^2 and above. Obesity is defined as a BMI of 30 kg/m^2 and above. A BMI of 30 kg/m^2 to less than 35 kg/m^2 is defined as class I obesity, a BMI between 35 kg/m^2 and 40 kg/m^2 as class II obesity, and a BMI of 40 kg/m^2 and higher as class III (morbid) obesity. A BMI of 25 kg/m^2 and less is defined as normal or underweight [22].

Historical data on mean BMI and obesity prevalence (since 1975) were obtained from previously published data on obesity in Egypt [6–17] and from the 2017 NCD Risk Factor Collaboration (NCD-RisC) study [23].

BMI data for patients with HCV viremia were obtained from the National Committee for Control of Viral Hepatitis (NCCVH) database at baseline before therapy with direct antiviral agents and compared to the general population by gender and age group.

Blood pressure was measured once in the sitting position using mercurial sphygmomanometers. Elevated blood pressure was considered if the blood pressure was $\geq$ 140 mmHg systolic and/or $\geq$ 90 mmHg diastolic. Blood glucose was measured using a capillary blood drop obtained through the same finger-prick used to test for the HCV antibody, using Accu-Check meters and strips from Roche Diabetes Care, Inc., Indianapolis, IN, USA. Persons were not required to be fasting or questioned about their fasting status, and all persons were presumed not to be fasting. Elevated blood glucose was considered if the blood glucose was 200 mg/dl or higher.

Statistical analysis

The following were calculated for country, state, and district levels: the percentage of persons in the target population who participated in screening and the prevalence of different weight categories among all screened persons categorized by gender and age group. Obesity prevalence was compared by gender and age group and compared to patients with hepatitis C infection. Results in each state

and district were compared and analyzed according to sex, age group, and urban versus rural residence.

To assess the global ranking of obesity in Egypt compared to other countries, the age-standardized prevalence of obesity was calculated [24]. Prevalence was compared to other countries' latest published age-standardized data obtained from the literature, and if no more-recent data was available, the WHO data for 2016 was used., [23, 25–28].

State obesity prevalence was correlated to state HCV prevalence obtained from the screening data [19] and to state poverty level from the 2018 Household Income, expenditure, and Consumption Survey (HIECS) from the Central Agency for Public Mobilization and Statistics (CAPMAS) [29].

Statistical analyses were performed using R software, version 4.2.1 (R Foundation for Statistical Computing), and R Studio version 2022.07.2 Build 576. Confidence intervals for percentages were calculated with the use of the Wilson method in R. Confidence intervals for differences in proportions, unadjusted for multiplicity, were used to compare proportions in groups, and a *P* value of less than 0.05 was considered to indicate statistical significance.

Prevalence maps were drawn using Quantum Geographic Information System (QGIS) version 3.34.1-Prizren and shapefiles for Egypt available from CAPMAS.

Results

49,630,319 adults (24,018,428 males and 25,611,891 females) were screened between October 2018 and April 2019 and have valid BMI data available. The total weight of the screened population was 4.1 million tons (4,111,330,478 kg) and the average BMI was 30.43 kg/m^2 (29.08 kg/m^2 for males and 32.22 kg/m^2 for females).

The overall prevalence of obesity (BMI ≥ 30 kg/m^2) was 39.84% (95% CI 39.82–39.85%) with more than 19.7 million persons affected by obesity and more than 3 million with class III (morbid) obesity in the screened population. In addition, 34.37% (95% CI 34.35–34.38%) were overweight. Prevalence of obesity and obesity classes was significantly higher in females (Table 1, Supplementary Figure S1), increased with age till age 55–64 in males and till age 45–54 in females, and was significantly more in females in all age groups (Table 2, Supplementary Figure S2).

Applying the same prevalence rates to the 2022 population, the current number of persons with obesity in Egypt would be 26,599,410 (10,285,741 males and 16,313,669 females), and the number of overweight persons 23,457,410 (13,424,059 males and 10,033,351 females) (Supplementary Table S1). Thus 73.85% of the adult population is estimated to be currently overweight or affected by obesity.

Table 3 and Fig. 1 show the geographic distribution of obesity in males and females. In all states, obesity prevalence was significantly higher in females. The prevalence of obesity and female obesity was highest in the Nile Delta states (female obesity prevalence in Dakahlia was 62.4% (95% CI 62.34–62.48) and in Gharbia 62.2% (95% CI 62.08–62.24), and more than 80% of adults in these two states are overweight or affected by obesity) and was lowest in the states in the south of the Nile valley with male obesity lowest in Qena (19.82% (95% CI 19.73–19.91)) (Figs. 1 and 2, Supplementary Figures 3–5). In no state was overall obesity prevalence

Table 1 Weight categories among Egyptian males and females

	Males		Females		Difference (females vs males)		Both Sexes	
	Number	% (95% CI)	Number	% (95% CI)	% (95% CI)	*p*	Number	% (95% CI)
BMI ≤ 25 kg/m^2	7,668,705	31.93% (31.91–31.94)	5,132,660	20.04% (20.02–20.05)	– 11.89% (11.86–11.91)	< 0.0001	12,801,365	25.79% (25.78–25.81)
Overweight BMI 25–29 kg/m^2	9,257,401	38.54% (38.52–38.56)	7,799,557	30.45% (30.43–30.47)	–8.09% (8.06–8.13)	< 0.0001	17,056,958	34.37% (34.35–34.38)
Obesity BMI ≥ 30 kg/m^2	7,092,322	29.53% (29.52–29.56)	12,679,674	49.51% (49.49–49.53)	19.98% (19.95–20.00)	< 0.0001	19,771,996	39.84% (39.82–39.85)
Obesity Class I (BMI 30–34 kg/m$^{2)}$	4,878,897	20.31% (20.30–20.34)	6,382,575	24.92% (24.91–24.94)	4.61% (4.58–4.63)	< 0.0001	11,261,472	22.69% (22.68–22.70)
Obesity Class II (BMI 35–39 kg/m$^{2)}$	1,622,929	6.76% (6.75–6.77)	3,785,235	14.78% (14.77–14.80)	8.02% (8.01–8.04)	< 0.0001	5,408,164	10.90% (10.89–10.91)
Obesity Class III (BMI ≥ 40 kg/m$^{2)}$	590,496	2.46% (2.45–2.47)	2,511,864	9.81% (9.80–9.82)	7.35% (7.34–7.36)	< 0.0001	3,102,360	6.25% (6.24–6.26)
	24,018,428		25,611,891				49,630,319	

Table 2 Prevalence of obesity (BMI ≥ 30 kg/m^2) among Egyptian males and females by age group

	Males			Females			Difference		Both Sexes		
Age	**Number screened**	**Number BMI ≥ 30 kg/m^2**	**% (95% CI)**	**Number screened**	**Number BMI ≥ 30 kg/m^2**	**% (95% CI)**	**% (95% CI)**	***p***	**Number screened**	**Number BMI ≥ 30 kg/m^2**	**% (95% CI)**
18–24	4,293,505	566,932	13.20% (13.17–13.23)	4,548,036	1,046,388	23.01% (22.97–23.05)	9.80 (9.75–9.8)	< 0.0001	8,841,541	1,613,320	18.25% (18.22–18.27)
25–34	6,374,630	1,368,490	21.47% (21.44–21.50)	6,999,168	3,118,569	44.56% (44.52–44.59)	23.09 (23.04–23.14)	< 0.0001	13,373,798	4,487,059	33.55% (33.53–33.58)
35–44	5,204,926	1,779,048	34.18% (34.14–34.22)	5,498,594	3,266,625	59.41% (59.37–59.45)	25.23 (25.17–25.28)	< 0.0001	10,703,520	5,045,673	47.14% (47.11–47.17)
45–54	3,753,884	1,616,335	43.06% (43.01–43.11)	3,838,429	2,470,377	64.36% (64.31–64.41)	21.30 (21.23–21.37)	< 0.0001	7,592,313	4,086,712	53.83% (53.79–53.86)
55–64	2,707,002	1,248,856	46.13% (46.07–46.19)	2,821,884	1,704,376	60.40% (60.34–60.46)	14.26 (14.18–14.34)	< 0.0001	5,528,886	2,953,232	53.42% (53.37–53.46)
65+	1,684,481	512,662	30.43% (30.36–30.50)	1,905,780	1,073,338	56.32% (56.25–56.39)	25.89 (25.79–25.98)	< 0.0001	3,590,261	1,586,000	44.18% (44.12–44.23)
All	24,018,428	7,092,322	29.53% (29.51–29.55)	25,611,891	12,679,674	49.51% (49.49–49.53)	19.98 (19.95–20.00)	< 0.0001	49,630,319	19,771,996	39.84% (39.82–39.85)

Table 3 State prevalence of obesity (BMI ≥ 30 kg/m^2) among Egyptian males and females

State	Males		Females		Both sexes	
	Screened	% BMI ≥ 30 kg/m^2 (95% CI)	Screened	% BMI ≥ 30 kg/m^2 (95% CI)	Screened	% BMI ≥ 30 kg/m^2 (95% CI)
Urban States						
Cairo	3,839,605	31.55 (31.50–31.59)	3,410,316	52.21 (52.15–52.26)	7,249,921	41.26 (41.23–41.30)
Alexandria	1,362,670	30.83 (30.76–30.91)	1,482,811	51.73 (51.65–51.81)	2,845,481	41.72 (41.67–41.78)
Port Said	204,507	34.47 (34.27–34.68)	192,350	57.73 (57.51–57.95)	396,857	45.75 (45.59–45.90)
Suez	195,728	32.03 (31.82–32.24)	193,949	55.62 (55.40–55.84)	389,677	43.77 (43.61–43.93)
Nile Delta States						
Damietta	388,743	36.33 (36.18–36.49)	394,651	57.82 (57.67–57.97)	783,394	47.16 (47.05–47.27)
Dakahlia	1,800,380	36.17 (36.10–36.24)	1,920,727	62.41 (62.34–62.48)	3,721,107	49.71 (49.66–49.77)
Sharkia	1,843,230	31.35 (31.29–31.42)	1,926,765	56.28 (56.21–56.35)	3,769,997	44.09 (44.04–44.14)
Kalyoubia	1,292,980	30.90 (30.82–30.98)	1,401,657	43.78 (43.70–43.87)	2,694,637	37.60 (37.54–37.66)
Kafr-El-Sheikh	773,826	34.66 (34.56–34.77)	912,965	56.48 (56.38–56.58)	1,686,791	46.47 (46.40–46.55)
Gharbia	1,243,240	36.74 (36.65–36.82)	1,451,173	62.16 (62.08–62.24)	2,694,413	50.43 (50.37–50.49)
Menoufia	975,005	32.96 (32.86–33.05)	1,126,945	54.21 (54.12–54.31)	2,101,950	44.35 (44.29–44.42)
Beheira	1,421,627	28.61 (28.53–28.68)	1,560,352	46.37 (46.29–46.44)	2,981,979	37.90 (37.84–37.95)
Ismailia	433,017	26.11 (25.98–26.24)	405,828	48.06 (47.91–48.22)	838,845	36.73 (36.63–36.83)
North Nile Valley States						
Giza	2,021,333	28.01 (27.95–28.07)	2,141,241	51.19 (51.12–51.25)	4,162,574	39.93 (39.88–39.98)
Beni Sueif	680,073	21.67 (21.58–21.77)	782,067	36.10 (35.99–36.20)	1,462,140	29.39 (29.31–29.46)
Fayoum	518,536	24.18 (24.06–24.29)	625,954	37.24 (37.12–37.36)	1,144,490	31.32 (31.24–31.41)
Minia	1,112,552	24.70 (24.62–24.78)	1,414,385	39.76 (39.68–39.84)	2,526,937	33.13 (33.07–33.19)
South Nile Valley States						
Assiut	919,991	20.26 (20.18–20.34)	1,033,800	31.82 (31.73–31.91)	1,953,791	26.38 (26.31–26.44)
Suhag	947,498	24.06 (23.97–24.15)	1,178,037	41.91 (41.82–42.00)	2,125,535	33.95 (33.89–34.02)
Qena	744,859	19.82 (19.73–19.91)	901,942	36.82 (36.72–36.92)	1,646,801	29.13 (29.06–29.20)
Aswan	392,697	22.91 (22.77–23.04)	440,125	45.45 (45.30–45.59)	832,822	34.82 (34.71–34.92)
Luxor	286,528	23.59 (23.44–23.75)	333,049	42.75 (42.58–42.92)	619,577	33.89 (33.77–34.01)
Desert States						
Red Sea	217,060	27.63 (27.44–27.82)	107,431	48.00 (47.70–48.30)	324,491	34.37 (34.21–34.54)
New Valley	82,093	25.86 (25.56–26.16)	74,836	45.42 (45.06–45.77)	156,929	35.18 (34.95–35.42)
Matrouh	154,643	23.67 (23.46–23.88)	93,277	43.35 (43.03–43.67)	247,920	31.07 (30.89–31.26)
North Sinai	83,319	25.12 (24.83–25.42)	81,840	42.86 (42.52–43.20)	165,159	33.91 (33.68–34.14)
South Sinai	82,686	26.30 (26.00–26.60)	23,418	45.13 (44.49–45.77)	106,104	30.46 (30.18–30.73)
Total	24,018,426	29.54 (29.52–29.56)	25,611,891	49.51 (49.49–49.53)	49,630,319	39.85 (39.83–39.86)

less than 25% or female obesity less than 30%, and in no state was the prevalence of overweight/obesity less than 60% overall and 70% in females. Morbid obesity (BMI ≥ 40 kg.m^2) prevalence was 6.25% (95% CI 6.24–6.26) overall, 2.96% (95% CI 2.45–2.47) in males and 9.81% (95% CI 9.80-9.82) in females and varied by state from 4.26 to 15.8% in females and from 1.5 to 3.5% in males (Table S6).

Overall and in all states, obesity was higher in urban than in rural areas (Supplementary Table S2). Supplementary Tables S3–S11 show the age-related prevalence of weight categories in all states.

State prevalence of obesity was inversely related to state prevalence of poverty (% of state population poor) with the states with the highest prevalence of poverty having the lowest prevalence of obesity ($r = -0.848$ (95% CI -0.929, -0.691), $p < 0.0001$, Fig. 3, Supplementary Table S12). State obesity prevalence was not related to state sero-prevalence of HCV ($r = 0.312$, (95% CI -0.077, 0.619), $p = 0.113$, Supplementary Table S12, Figure S6).

HCV

Weight data were obtained from the NCCVH database for 355,504 patients with HCV viremia at baseline before

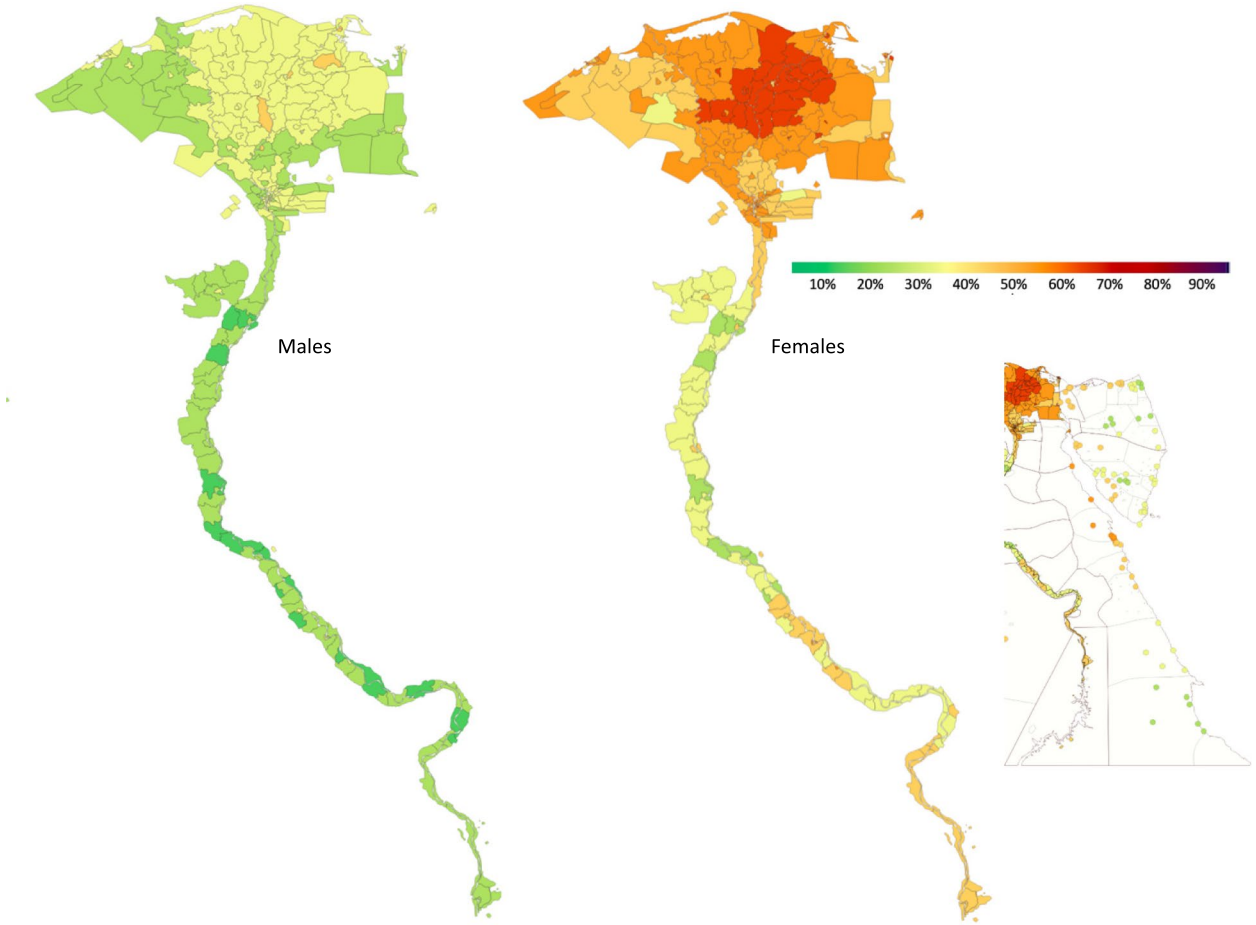

Fig. 1 District-level prevalence of obesity (BMI ≥ 30 kg/m^2) in males and females. The enlarged area of the country maps includes the Urban, Nile Delta, and Nile Valley States (98.3% of the population)

therapy (187,559 males and 167,945 females) (Tables 4, 5, 6 and 7). Similar to the prevalence in the screened general population, the prevalence of obesity in patients with HCV viremia was significantly higher in females (47.12% (95% CI 46.88–47.36%) vs 26.09% (95% CI 25.89–26.29%), (Supplementary Table S13, Figure S8) and increased with age till age 60 (Table S14, Figure S9). The prevalence of obesity was significantly lower in HCV patients than in the screened population (difference 3.54% (95% CI 3.24–3.64%) and 2.39% (95% CI 2.15–2.63%) in males and females respectively) (Supplementary Table S15, Supplementary Figure S9), and in all age groups (Supplementary Table S16).

Global ranking

Other than the 10 Pacific Island countries, Kuwait is the country with the highest prevalence of obesity followed by Qatar and the USA. Egypt ranks 4th country globally in overall obesity and ranks 1st in female obesity (Supplementary Table S17).

Elevated blood pressure and blood glucose

Five thousand three hundred forty-four persons (0.01%) had missing blood pressure and blood glucose data, and the analysis includes data for 49,624,975 persons. The prevalence of elevated blood pressure (> 140 mmHg systolic and/or 90 mmHg diastolic) was 21.03% (95% CI 21.02–21.05), was more common in males nationally and in all states, increased with age and was higher in urban than rural areas (Supplementary Table S18). The prevalence of elevated blood glucose (> 200 mg/dl) was 5.19% (95% CI 5.18–5.19), increased with age, was higher in females, and was higher in urban than rural areas (Supplementary Table S18).

Discussion

Globally, people are at higher risk of dying prematurely from NCDs. This risk is highest in low- and middle-income countries where the capacity to identify and treat NCDs might not be adequate. In Egypt, 84% of annual mortalities are attributed to NCDs [30]. We show that,

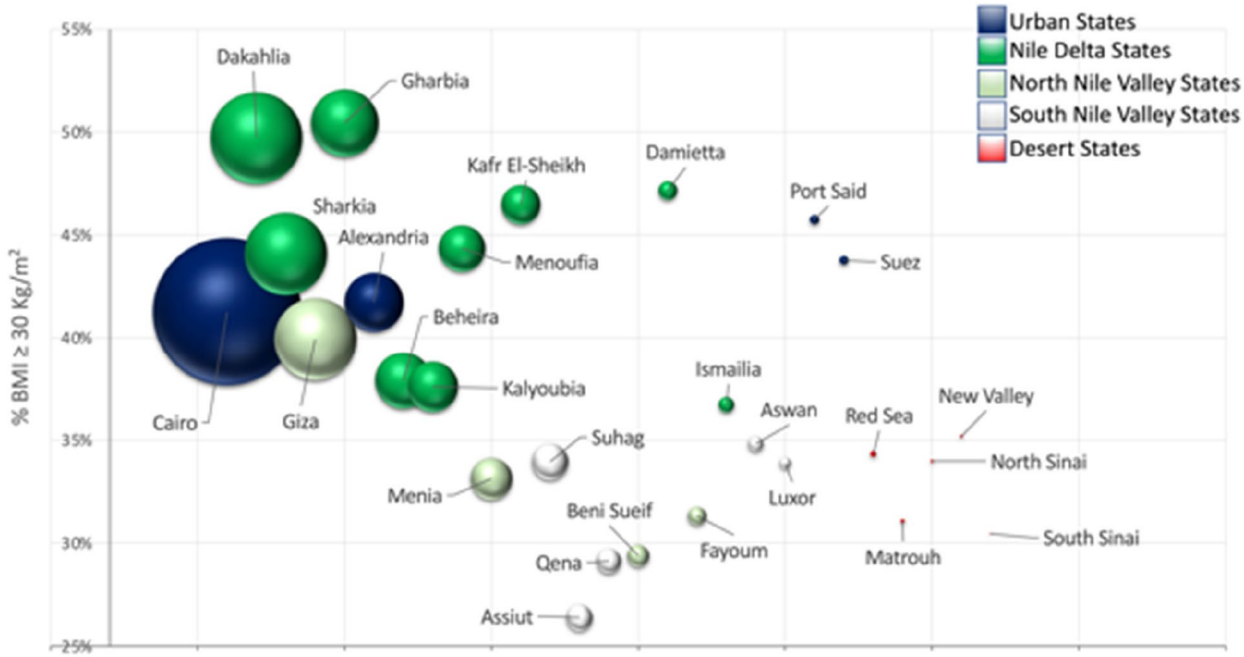

Fig. 2 Bubble chart for the state prevalence of obesity (BMI ≥ 30 kg/m^2) and number of persons with obesity in the screening program. The size of the bubble represents the number of persons with obesity in the state, and the y-axis is the prevalence of obesity (%) in the state. The states are arranged by the number of persons with obesity on the *x*-axis, with the largest number of persons with obesity to the far left, and the least numbers to the far right

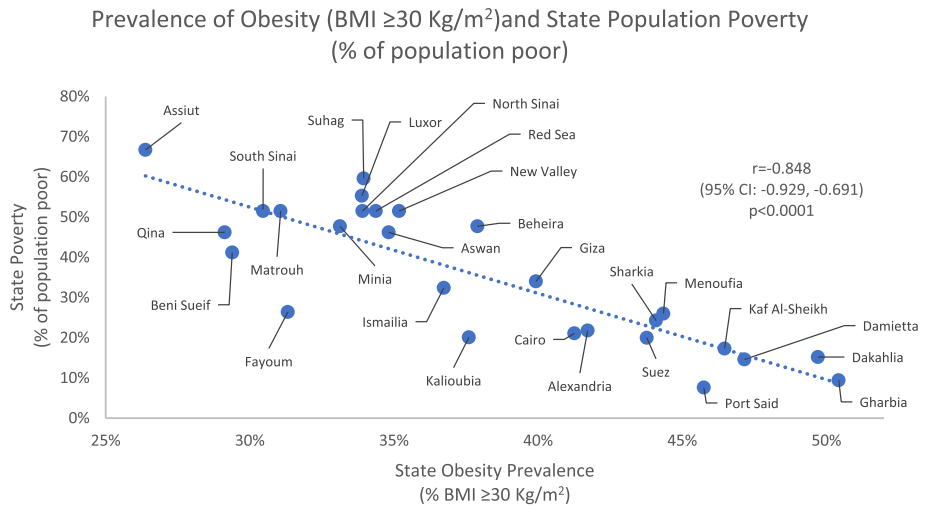

Fig. 3 Correlation between state prevalence of obesity (BMI ≥ 30 kg/m^2) and state prevalence of poverty (% of state population poor)

similar to the increasing global prevalence of obesity [1, 31, 32], the overall prevalence of obesity in Egypt has increased. Obesity prevalence had doubled from 12% in 1975 to 24% in 2003 [33], and the results presented here show that the prevalence has more than tripled to a prevalence rate of 39.84% (95% CI 39.82–39.85) by 2019 (Fig. 4). With the current data, Egypt has become the country with the highest prevalence of female obesity in the region and globally after the scarcely populated Pacific Island Nations [32–35].

Ward et al. [36] classified obesity into moderate (BMI ≥ 30–< 35 kg/m^2) and severe (BMI ≥ 35 Kg/m^2) in their study on the future of obesity in the USA; a classification that is also used by the US National Center for Health Statistics (NCHS) in its reports on obesity in the USA [25]. In this analysis, however, we used the WHO's

Table 4 Weight categories in male and female patients with HCV

		Females	Males	% Difference (95% CI)	*P*	Total
BMI ≤ 25 kg/m^2	Number	28,222	54,476			82,698
	% (95%CI)	16.8% (16.63–16.98)	29.04% (28.84–29.25)	12.24% (11.97–12.51)	< 0.0001	23.26% (23.12–23.40)
BMI 25–29 kg/m^2	Number	60,588	84,151			144,739
	% (95% CI)	36.08% (35.85–36.31)	44.87% (44.64–45.09)	8.79% (8.47–9.11)	< 0.0001	40.71% (40.55–40.88)
BMI ≥ 30 kg/m^2	Number	79,135	48,932			128,067
	% (95% CI)	47.12% (46.88–47.36)	26.09% (25.89–26.29)	21.03% (20.72–21.34)	< 0.0001	36.02% (35.87–36.18)
Total	Number	167,945	187,559			355,504

Table 5 Weight categories in different age groups in patients with HCV

Age group		18–24	25–34	35–44	45–54	55–64	65+	Total
BMI ≤ 25 kg/m^2	Number	3969	10,393	12,156	22,505	23,503	9,803	82,329
	% (95% CI)	46.97% (45.90–48.04)	31.93% (31.43–32.44)	21.82% (21.48–22.17)	19.82% (19.59–20.06)	21.56% (21.31–21.80)	27.05% (26.59–27.51)	23.16% (23.02–23.30)
BMI 25–29 kg/m^2	Number	3177	13,763	23,205	46,280	43,989	14,131	144,545
	% (95% CI)	37.60% (36.56–38.64)	42.29% (41.75–42.83)	41.66% (41.25–42.07)	40.76% (40.48–41.05)	40.34% (40.05–40.64)	38.99% (38.49–39.500	40.66% (40.50–40.82)
BMI ≥ 30 kg/m^2	Number	1304	8389	20,341	44,746	41,544	12,306	128,630
	% (95% CI)	15.43% (14.67–16.22)	25.78% (25.30–26.26)	36.52% (36.12–36.92)	39.41% (39.13–39.70)	38.10% (37.81–38.39)	33.96% (33.47–34.45)	36.18% (36.02-36.34)
Total		8450	32,545	55,702	113,531	109,036	36,240	355,504

Table 6 Weight categories in males and females in patients with HCV and screened population

		Number BMI ≥ 30 kg/m^2	% (95% CI)	% Difference (95% CI)	*P*
Females	HCV	79,135	47.12% (46.88–47.36)	2.39% (2.15–2.63)	< 0.0001
	All	12,679,674	49.51% (49.49–49.53)		
Males	HCV	48,932	26.09% (25.89–26.29)	3.54% (3.24–3.64)	< 0.0001
	All	7,092,322	29.53% (29.52–29.56)		
Both sexes	HCV	128,067	36.02% (35.87–36.18)	3.82% (3.66–3.97)	< 0.0001
	All	19,771,996	39.84% (39.82–39.85)		

definitions of obesity classes and its classification into 3 classes, with BMI ≥ 35 divided into Class II (BMI ≥ 35–< 40 kg/m^2) and Class III or morbid obesity (BMI ≥ 40 kg/m^2) [22].

Similar to most countries in the Mediterranean and Middle East region [28], and unlike most countries in Europe [37] and recent data from the USA [25], the prevalence of obesity in Egypt is higher in females than in males.

The NCD Risk Factor Collaboration (NCD-RisC) projected that the prevalence of obesity in Egypt would increase from an estimated prevalence of 38.3% (95% CI 33.1–43.5%) in women and 19.4% (95% CI 14.9–24.4) in men in 2010 to a projected prevalence of 49.4% (95% CI 39.3–59.5%) in women and 31.4% (95% CI 21.3–42.8%) in men by 2025 [18]. Here we show that obesity prevalence in women in 2019 has surpassed the level projected for 2025 by the NCD-RisC, reaching a prevalence of 49.51% (95% CI 49.49–49.53%), while the 2019 male prevalence of obesity (29.53% (95% CI 29.52–29.56%)) has come close the 2025 projected level.

Obesity as a global health problem has been recognized and addressed by several international policy strategies and plans. The World Health Assembly in 2004 [38] and the 2011 United Nations General Assembly's High-Level Political Declaration on the Prevention and Control of Non-communicable Diseases (NCDs) ([39] resulted in the introduction of the "WHO Global Strategy on Diet,

Table 7 Weight categories in different age groups in patients with HCV and screened population

Age group	HCV viremic patients			All screened			Difference % (95% CI)	*P*
	BMI ≥ 30 kg/m^2	Total	%	BMI ≥ 30 kg/m^2	Total	%		
18–24	1304	8450	15.43% (14.67–16.22)	1,613,320	8,841,541	18.25% (18.22–18.27)	2.82% (2.04–3.59)	< 0.0001
25–34	8389	32,545	25.78% (25.30–26.26)	4,487,059	13,373,798	33.55% (33.53–33.58)	7.77% (7.30–8.25)	< 0.0001
35–44	20,341	55,702	36.52% (36.12–36.92)	5,045,673	10,703,520	47.14% (47.11–47.17)	10.62% (10.22–11.02)	< 0.0001
45–54	44,746	113,531	39.41% (39.13–39.70)	4,086,712	7,592,313	53.83% (53.79–53.86)	14.41% (14.13–14.70)	< 0.0001
55–64	41,544	109,036	38.10% (37.81–38.39)	2,953,232	5,528,886	53.42% (53.37–53.46)	15.31%)15.02–15.61)	< 0.0001
65+	12,306	36,240	33.96% (33.47–34.45)	1,586,000	3,590,261	44.18% (44.12–44.23)	10.22% (9.73–10.71)	< 0.0001
Total	128,630	355,504	36.18% (36.02–36.34)	19,771,996	49,630,319	39.84% (39.82–39.85)	3.66% (3.50–3.81)	< 0.0001

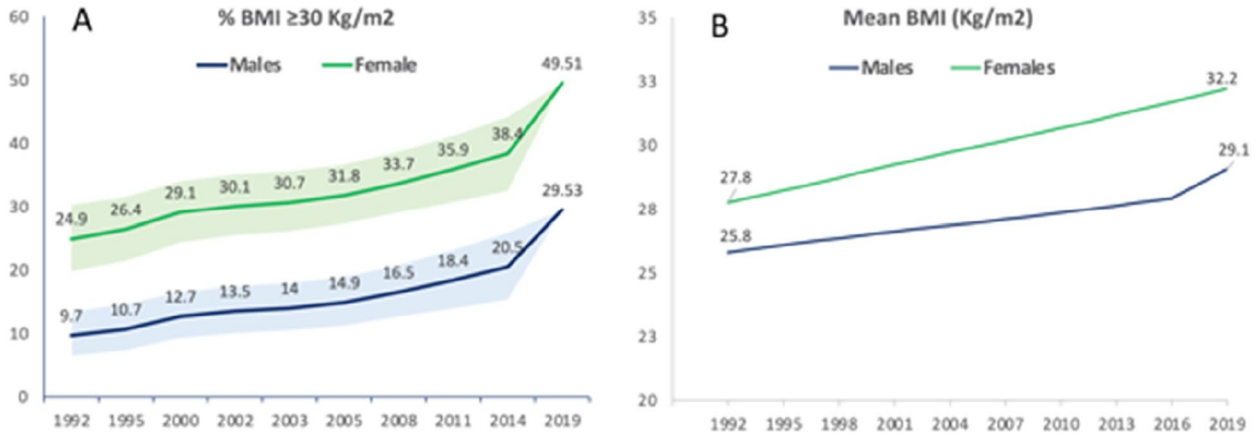

Fig. 4 Trend of the prevalence of obesity (BMI≥ 30 kg/m^2) with confidence intervals (**A**) and of mean BMI (**B**) in males and females since 1992

Physical Activity and Health" that describes actions to support healthy diets and regular physical activity [40]. In addition, the "Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World" provides policy actions to increase physical activity globally as measures to address the global rise in the prevalence of obesity.

The targets for alleviating the impact of NCDs agreed upon by member states of the World Health Organization in 2013 [41] include a 25% reduction of premature deaths from non-communicable diseases by 2025, and halting the increase in the rise of obesity by the year 2025 to the prevalence level of 2010 [40], a target that is unachievable in Egypt. The overall prevalence of obesity in Egypt in 2010 was 27.2% (95% CI 23.9–29.8%), of male obesity was 18.4% (95% CI 14–23.3%) and of female obesity 35.9% (95% CI 30.8–41.2%). Although the rate of increase of the prevalence of obesity has been decreasing slightly in Egypt over the last three decades, the 2019 prevalence data (60% increase in male obesity and 38% increase in female obesity over the 2010 levels) indicate that the WHO's target of a prevalence in 2025 equal to the 2010 levels cannot be achieved. Although the rate of increase of obesity appears leveling off or stagnating in several high-income countries [42–45], this does not appear to be happening any time soon in Egypt, and unless major changes take place, the increasing trend will continue.

What makes the problem more crucial is the high prevalence of obesity in young adults. Between age 18 and 25, 34% are overweight and 18% are affected by obesity, with 58% in Gharbia in the Nile Delta either overweight or affected by obesity. Among all those younger than 35, 64% are either overweight or affected by obesity, a prevalence that reaches 78% in the several Nile Delta states. In addition, of 17,045,798 women of child-bearing age

screened, 43.60%, (95% CI 43.57–43.62%) were affected by obesity. This increases the possibility of obesity in their children, as the risk of childhood and future obesity increases by more than 250% with maternal obesity [46]. Overweight/obesity that starts at a young age indicates that interventions and efforts to address the problem must start early in life and must include interventions to reduce obesity in all women of reproductive age.

Halting the increase in obesity requires the national adoption of comprehensive social, educational, and food policies to change the population's eating habits and promote physical activity. In acknowledgement of the problem, the Egyptian government and the MoH have started to undertake several steps to confront the high prevalence and increasing trend of obesity. A sin-tax is being prepared for beverages with sugar levels exceeding 5 mg/100 ml. Annual follow-up of schoolchildren in school clinics and MoH primary healthcare facilities includes anthropometric measures, and since 2019, all schoolchildren between 6 and 12 years have annually screened for obesity, anemia, and stunting. For adults, efforts to advertise and promote exercise and physical activity have started, and the number of nutrition clinics supervised by the National Nutrition Institute and bariatric surgery centers in government hospitals has been scaled up. However, with the current prevalence in this report, a comprehensive national plan should be employed to address this important problem and to halt and reverse the rising trend. The results in this report highlight the hottest spots of obesity which require intensive interventions on behalf of the MoH and policy makers.

These data show that, excluding the Pacific Island countries, Egypt has become the fourth country globally in overall obesity and ranks first in female obesity, with an age-standardized prevalence of obesity of more than 50% in adult females. Published data for other countries, however, are based on rather old screening studies (the latest available data and published reports for Qatar are based on the 2012 STEPS and for Kuwait on the 2014 STEPS reports). This ranking might change when more recent data become available from other countries.

The high prevalence of overweight and obesity is undoubtedly having and will continue to have a large impact on health in Egypt. It is probably a major factor in the 17.2% (95% CI 9.2–19.6) prevalence of T2DM [47], and the 29.2% (95% CI 27.5–31.0) prevalence of hypertension reported in the 2017 STEPS survey [15] among Egyptian adults. This high prevalence of obesity is probably also contributing to the incidence of cardiovascular, cerebrovascular, and musculoskeletal diseases, cognitive decline, many types of cancer, and overall mortality [1]. The economic impact, both in direct and indirect cost, has not been calculated and is expected to be massive.

The reason for the high prevalence of overweight and obesity in Egypt is probably multifactorial. The type of diet with high content of wheat and carbohydrates is a contributing factor, where the per-capita consumption of wheat and sugar in Egypt are among the highest in the world with national per-capita wheat consumption three times the global per-capita average and sugar consumption double the global per-capita average [48]. Over the past three decades, Egypt has witnessed increasing personal income, which probably impacted the increase in the prevalence of obesity as evidenced by the inverse correlation of state obesity prevalence and state poverty level. In addition, Egypt has seen an increase in urbanization and a sedentary lifestyle, which is coupled with a lack of exercise and physical activity, and cultural factors limiting female exercise. These factors contribute to the impact of diet habits in increasing the prevalence of overweight and obesity.

Prevalence of obesity in patients with hepatitis C viremia was lower than in the screened population, but similar to the screened population, increased with age till age 60, and was higher in females than in males in all age groups. In all age groups and in males and females, patients with HCV were less affected by obesity than the screened general population. The reason for the lower prevalence of obesity in HCV patients is not directly known, and the severity of liver disease in these patients was not evaluated.

The strength of this study is the huge sample size which is the largest screening campaign and BMI evaluation in history.

However, the study also had several limitations.

Although the European Association for the Study of the Liver (EASL), the European Association for the Study of Diabetes (EASD), and the European Association for the Study of Obesity (EASO), in joint clinical practice guidelines, recommended screening for non-alcoholic fatty liver disease (NAFLD) in people with obesity [49], yet the persons with obesity in this program were not screened for NAFLD by laboratory tests or ultrasound, and we cannot comment on the prevalence of NAFLD from our results.

The only anthropometric measure calculated in this screening program was the BMI. Several reports suggest that waist-circumference, waist-hip ratio, and waist-height ratio are better measures to predict the risk of development of cardiovascular disease or diabetes in relation to obesity [50–52]. We did not record waist circumference, and none of these measures were registered in the current screening.

No questionnaires or data were collected regarding dietary and exercise habits, personal and household income, or social parameters. The huge number of

screened population and large daily flow (the average daily flow was 230,000 persons, and as many as 550,000 persons were screened in one day when the screening campaign was ongoing in Cairo) did not allow for collecting these data.

Although obesity is a known risk factor for the development of T2DM and hypertension, its role in the screened population cannot be determined from the current data. The screening program identified 2.57 million persons (5.19% (95% CI 5.18–5.19) of the screened population) with blood glucose ≥ 200 mg/dl. However, these do not represent the prevalence of diabetes in Egypt. The number of patients with diabetes and blood glucose < 200 mg/dl on medication for raised blood glucose among the screened population is not known, the fasting state of the screened population was not recorded, and the prevalence of diabetes in the population and its correlation to weight categories cannot be determined. In the WHO's 2017 Egypt STEPS survey, the total prevalence of elevated blood glucose or treatment for diabetes was 15.5 [15], and the International Diabetes Federation (IDF) estimated the prevalence of T2DM in adults in Egypt in 2017 at 15.1% [95% CI 8.1–17.2] [47]. Similarly, although the prevalence of elevated blood pressure in the screened population was 21.03% (95% CI 21.02–21.05%), this does not represent the prevalence of hypertension in the screened population, and the number of persons on anti-hypertensive medication is not known. In the WHO's 2017 Egypt STEPS survey that included data for 6680 adults, the percentage of persons with elevated blood pressure or on anti-hypertensive medication was 29.5% (95% CI 28.0–31.0%) [15].

In conclusion, this is the largest national screening program for overweight and obesity, where we have highlighted that obesity is a major health problem in Egypt and that its prevalence is still increasing, and is currently among the highest in the world. Addressing the problem requires the national adoption of comprehensive social, educational, and food policies and the promotion of physical activity. We have highlighted that the obesity problem starts in young adults and identified the high prevalence areas at the district level.

Abbreviations

BMI	Body mass index
CAPMAS	Central Agency for Public Mobilization and Statistics
CDC	Center for Disease Control and Prevention
CI	Confidence intervals
DHS	Demographic and Health Survey
EASD	European Association for the Study of Diabetes
EASL	European Association for the Study of the Liver
EASO	European Association for the Study of Obesity
HCV	Hepatitis C virus
HIS	Health issue survey
IDF	International Diabetes Federation
MCIT	Ministry of Communication and Information Technology
MoH	Ministry of Health
NAFLD	Non-alcoholic fatty liver disease
NCCVH	National Committee for the Control of Viral Hepatitis
NCD	Non-communicable diseases
NCD-RisC	Non-communicable diseases risk factor collaboration
STEPS	STEPwise approach to Surveillance
T2DM	Type 2 diabetes mellitus
USA	United States of America
WHO	World Health Organization

Supplementary Information

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Additional file 1: Supplementary Figure S1. Prevalence of weight categories in females (A) and males (B). **Supplementary Figure S2.** Prevalence of obesity (BMI ≥30 Kg/m^2) by age group. **Supplementary Figure S3.** Weight categories by State in both sexes. **Supplementary Figure S4.** Weight categories by State in females. **Supplementary Figure S5.** Weight categories by State in males. **Supplementary Figure S6.** Relation Between State Prevalence of Obesity and HCV Seroprevalence. **Supplementary Figure S7.** Prevalence of obesity (BMI≥30 Kg/m^2) in males and females with HCV viremia. **Supplementary Figure S8.** Prevalence of obesity (BMI≥30 Kg/m^2) in patients with HCV viremia and the total screened population. **Supplementary Table S1.** Estimated prevalence of overweight/obesity in 2022. **Supplementary Table S2.** Prevalence of obesity (BMI ≥30 Kg/m^2) in Urban and Rural communities in Egypt. **Supplementary Table S3.** Prevalence of % BMI 25-29.9 Kg/m^2 by sex and age group in different States. **Supplementary Table S4.** Prevalence of % BMI 30-34.9 Kg/m^2 by sex and age group in different States. **Supplementary Table S5.** Prevalence of % BMI 35-39.9 Kg/m^2 by sex and age group in different States. **Supplementary Table S6.** Prevalence of % BMI ≥40 Kg/m^2 by sex and age group in different States. **Supplementary Table S7.** Prevalence of % BMI ≥25 Kg/m^2 by sex and age group in different States. **Supplementary Table S8.** Prevalence of % BMI ≥30 Kg/m^2 by sex and age group in different States. **Supplementary Table S9.** % with different BMI categories (sorted by BMI ≥30 Kg/m2) in both sexes in different States. **Supplementary Table S10.** % with different BMI categories (sorted by BMI ≥30 Kg/m2) in females in different States. **Supplementary Table S11.** % with different BMI categories (sorted by BMI ≥30 Kg/m2) in males in different States. **Supplementary Table S12.** Prevalence of obesity (BMI ≥30 Kg/m^2), HCV sero-positivity, and poverty in different states. **Supplementary Table S13.** Weight categories in male and female patients with HCV. **Supplementary Table S14.** Weight Categories in Different Age Groups in Patients with HCV. **Supplementary Table S15.** Weight categories in males and females in patients with HCV and screened population. **Supplementary Table S16.** Weight Categories in different age groups in patients with HCV and screened population. **Supplementary Table S17.** Age standardized prevalence of obesity (BMI ≥30 Kg/m^2) in Egypt and other countries. **Supplementary Table S18.** Prevalence of elevated blood pressure and blood glucose in the screened population.

Authors' contributions

Screening campaign planning: Hala Zayed, Wahid Doss, Gamal Esmat, Mohamed Hassany, Manal H El Sayed, and Khaled Kabil. Screening campaign administration and management: Hala Zayed, Mohamed Hassany, Wael Abdel-Razek, Galal Elshishiny, Khaled Kabil, Ahmed Cordie, Yasser Omar, Ramy SaeedIslam Ammar, and Mohammed Abdalla. Software development and database management: Tarek Saad, Ayasm Salah. Data collection: Wael Abdel-Razek. Data analysis: Imam Waked, Wafaa El Akel. Literature search: Wafaa El Akel. Figures: Imam Waked. Manuscript writing: Gamal Esmat, Imam Waked, and Wafaa El Akel. All authors revised and approved the final version of the manuscript.

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Availability of data and materials
Data were generated from the central database of the NCCVH of the MoH in Egypt. The data that support the findings of this study are available on request from the corresponding author, [IW]. The individual raw data are not publicly available due to their containing individual data for 49.6 million persons.

Declarations

Ethics approval and consent to participate
As individual and personal data are not made public and are unknown to the authors, the study has been granted an exemption from requiring ethics approval by the Ethics Committee and the board of the National Committee for the Control of Viral Hepatitis (NCCVH) of the Ministry of Health (MoH) in Egypt. All persons coming for screening came voluntarily without any incentive or possible punitive consequences for not participating.

Consent for publication
All data used for the analysis for this publication were anonymized and no personal or individual data are known. No signed consent form was obtained from the 49.6 million persons participating in the screening, and the ethics committee of the MoH decided that the persons' voluntary participation in the screening program was sufficient to use their anonymous data for analysis of disease prevalence.

Competing interests
All authors declare that they have no competing interests.

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References

1. Afshin A, Forouzanfar MH, Reitsma MB, Sur P, Estep K, Lee A et al (2017) Health effects of overweight and obesity in 195 countries over 25 years. N Engl J Med. 377(1):13–27
2. Dai H, Alsalhe TA, Chalghaf N, Ricco M, Bragazzi NL, Wu J (2020) The global burden of disease attributable to high body mass index in 195 countries and territories, 1990-2017: An analysis of the Global Burden of Disease Study. PLoS Med. 17(7):e1003198
3. Global BMI Mortality Collaboration, Di Angelantonio E, Bhupathiraju Sh N, Wormser D, Gao P, Kaptoge S et al (2016) Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. Lancet 388(10046):776–786
4. Bray GA, Kim KK, JPH W, World Obesity Federation (2017) Obesity: a chronic relapsing progressive disease process. A position statement of the World Obesity Federation. Obes Rev 18(7):715–723
5. World Health Organization. Obesity and overweight. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed 28 Mar 2024
6. El-Zanaty and Associates (1997) Cairo. Egypt, Macro International Inc. Calverton M. Egypt Demographic and Health Survey. Available at: https://dhsprogram.com/pubs/pdf/FR167/FR167.pdf. Accessed 28 Mar 2024
7. FH El-Z, HAA S, HHM Z, Way A (1992) Egypt demographic and health survey 1992. National Population Council Cairo, Egypt, Macro International Inc., Calverton, Maryland. Available at: https://dhsprogram.com/pubs/pdf/FR48/FR48.pdf. Accessed 28 Mar 2024
8. El-Zanaty F, Hussein EM, Shawky GA, Way AA, Kishor S (1995) Egypt demographic and health survey 1995. National Population Council Cairo, Egypt, Macro International Inc., Calverton, Maryland. Available at: https://dhsprogram.com/pubs/pdf/FR71/FR71.pdf. Accessed 28 Mar 2024
9. El-Zanaty F, Way A (2001) Egypt demographic and health survey 2000. Ministry of Health and Population [Egypt], National Population Council and ORC Macro, Calverton, Maryland. Available at: https://dhsprogram.com/pubs/pdf/FR117/FR117.pdf. Accessed 28 Mar 2024
10. El-Zanaty F, Way A (2006) Egypt demographic and health survey 2005. Cairo, Egypt, Ministry of Health and Population, National Population Council, El-Zanaty and Associates, and ORC Macro. Available at: https://www.dhsprogram.com/pubs/pdf/FR176/FR176.pdf. Accessed 28 Mar 2024
11. El-Zanaty F, Way A (2008) Egypt demographic and health survey 2008. Ministry of Health, El-Zanaty and Associates, and Macro International, Cairo. Available at: https://dhsprogram.com/pubs/pdf/fr220/fr220.pdf. Accessed 28 Mar 2024
12. El-Zanaty F, Way AA (2003) Egypt interim demographic and health survey. Cairo Egypt: Ministry of Health and Population [Egypt], National Population Council, E1-Zanaty and Associates, and ORC Macro, p 2004. Available at: https://dhsprogram.com/pubs/pdf/FR149/FR149.pdf. Accessed 28 Mar 2024
13. Ministry of Health & population, Egypt Preventive Sector Central Epidemiology and Disease Surveillance (ESU) Non-Communicable Disease Surveillance Unit (NCDSU) Community based survey study On Non-communicable diseases and their Risk Factors, Egypt, 2005-2006. Available at: https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/egpyt/steps/steps-report-egypt-2005-06.pdf?sfvrsn=de47507a_2&download=true. Accessed 28 Mar 2024
14. Ministry of Health and Population (Egypt), United States Agency for International Development (USAID), World Health Organization (WHO). Egypt STEPS Survey 2011-12 Fact Sheet. Available at: https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/egpyt/steps/2011-2012-egypt-factsheet.pdf?sfvrsn=3088d63b_2&download=true. Accessed 28 Mar 2024
15. Ministry of Health and Population (Egypt), United States Agency for International Development (USAID), World Health Organization (WHO). Egypt STEPS Survey 2017 Fact Sheet. Available at: https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/egpyt/steps/egypt-steps-survey-2017-fact-sheet.pdf?sfvrsn=33c64cb7_2&download=true. Accessed 28 Mar 2024
16. Ministry-of-Health-and-Population-[Egypt], El-Zanaty-and-Associates-[Egypt], ICF-International (2015) Egypt health issues survey 2015. Ministry of Health and Population and ICF International, Cairo, Egypt and Rockville, Maryland. Available at: https://dhsprogram.com/pubs/pdf/FR313/FR313.pdf. Accessed 28 Mar 2024
17. Ministry-of-Health-and-Population-Egypt, El-Zanaty-and-Associates-Egypt, ICF-International (2015) Egypt demographic and health survey 2014. Ministry of Health and Population and ICF International., Cairo, Egypt and Rockville, Maryland. Available at: https://dhsprogram.com/pubs/pdf/fr302/fr302.pdf. Accessed 28 Mar 2024
18. NCD Risk Factor Collaboration (NCD-RisC). Egypt: Body Mass Index: projections for 2025. Available at: https://ncdrisc.org/downloads/country-pdf/NCD-RisC%20country%20factsheet%20Egypt.pdf. Accessed 28 Mar 2024
19. Waked I, Esmat G, Elsharkawy A, El-Serafy M, Abdel-Razek W, Ghalab R et al (2020) Screening and Treatment Program to Eliminate Hepatitis C in Egypt. N Engl J Med 382(12):1166–1174
20. Esmat G, El-Sayed MH, Hassany M, Doss W, Waked I (2018) One step closer to elimination of hepatitis C in Egypt. The Lancet. Gastroenterol Hepatol 3(10)
21. Online A. Egypt's population has reached 104 million: CAPMAS 2022. Available from: https://english.ahram.org.eg/News/477062.aspx. Accessed 28 Mar 2024
22. World Health Organization. Body mass index - BMI. Available at: https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations. Accessed 28 Mar 2024
23. NCD Risk Factor Collaboration (2017) Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement

studies in 128.9 million children, adolescents, and adults. Lancet 390(10113):2627–2642
24. Ahmad O, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M (2001) Age standardization of rates: a new who standard. Available at: https://cdn.who.int/media/docs/default-source/gho-documents/global-health-estimates/gpe_discussion_paper_series_paper31_2001_age_standardization_rates.pdf. Accessed 28 Mar 2024
25. Hales CM, Carroll MD, Fryar CD, Ogden CL (2020) Prevalence of obesity and severe obesity among adults: United States, 2017–2018. NCHS Data Brief, no 360. National Center for Health Statistics, Hyattsville. Available at: https://www.cdc.gov/nchs/data/databriefs/db360-h.pdf. Accessed 28 Mar 2024
26. Oguoma VM, Coffee NT, Alsharrah S, Abu-Farha M, Al-Refaei FH, Al-Mulla F et al (2021) Prevalence of overweight and obesity, and associations with socio-demographic factors in Kuwait. BMC Public Health 21(1):667
27. Qatar Ministry of Public Health. Healthy Lifestyle. Available at: https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/qatar/steps/qatar-factsheet-2012.pdf?sfvrsn=2e4a4e16_2&download=true. Accessed 28 Mar 2024
28. World Health Organization, The Global Health Observatory (2017) Prevalence of obesity among adults, BMI >= 30 (age-standardized estimate) (%). Available at: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/prevalence-of-obesity-among-adults-bmi-=-30-(age-standardized-estimate)-(-). Accessed 28 Mar 2024
29. Central Agency for Public Mobilization and Statistics (CAPMAS) (2018) Household income, expenditure and consumption survey 2017-2018. Available at: https://www.capmas.gov.eg/Admin/Pages%20Files/2019123101612income1.pdf. Accessed 28 Mar 2024
30. World Health Organization (2018) Noncommunicable Diseases (NCD) Country Profiles, 2018. EGYPT. Available at: https://cdn.who.int/media/docs/default-source/country-profiles/ncds/egy_en.pdf?sfvrsn=2a1d9633_36&download=true. Accessed 28 Mar 2024
31. NCD Risk Factor Collaboration (NCD-RisC) (2016) Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. Lancet 387(10026):1377–1396
32. Swinburn BA, Kraak VI, Allender S, Atkins VJ, Baker PI, Bogard JR et al (2019) The global syndemic of obesity, undernutrition, and climate change: The Lancet Commission report. Lancet 393(10173):791–846
33. World Health Organization (2019) Prevalence of obesity among adults, BMI ≥ 30, age-standardized Estimates by country. Available at: http://apps.who.int/gho/data/node.main.A900A?lang=en. Accessed 28 Mar 2024
34. World Obesity Federation (2019) Global prevalence of adult overweight & obesity by Region. Available from: https://ps-wod-web-prod.s3.amazonaws.com/media/filer_public/7c/54/7c54443f-8fd0-482b-9da2-762982032081/adult_eng_160719.pdf. Accessed 28 Mar 2024
35. World Population Review (2019) Most obese countries. Available at: http://worldpopulationreview.com/countries/most-obese-countries/. Accessed 28 Mar 2024
36. Ward ZJ, Bleich SN, Cradock AL, Barrett JL, Giles CM, Flax C et al (2019) Projected U.S. State-Level Prevalence of Adult Obesity and Severe Obesity. N Engl J Med 381(25):2440–2450
37. Janssen F, Bardoutsos A, Vidra N (2020) ObeSITY PREVALENCE IN THE LONG-TERM FUTURE in 18 European countries and in the USA. Obes Facts 13(5):514–527
38. World Health Organization (2004) Global strategy on diet, physical activity and health. Available at: https://apps.who.int/gb/archive/pdf_files/WHA57/A57_9-en.pdf. Accessed 28 Mar 2024
39. United Nations General Assembly (2012) Political declaration of the high-level meeting of the general assembly on the prevention and control of non-communicable diseases. Available at: https://digitallibrary.un.org/record/710899/files/A_66_L-1-EN.pdf?ln=en. Accessed 28 Mar 2024
40. World Health Organization (2018) Global action plan on physical activity 2018–2030: More active people for a healthier world. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO. Available at: https://www.who.int/publications/i/item/9789241514187. Accessed 28 Mar 2024
41. World Health Organization (2013) Global action plan for the prevention and control of noncommunicable diseases 2013-2020. Available at: https://ncdalliance.org/sites/default/files/rfiles/WHO%20Global%20NCD%20Action%20Plan%202013-2020.pdf. Accessed 28 Mar 2024
42. Kontis V, Mathers CD, Rehm J, Stevens GA, Shield KD, Bonita R et al (2014) Contribution of six risk factors to achieving the 25x25 non-communicable disease mortality reduction target: a modelling study. Lancet 384(9941):427–437
43. Lauria L, Spinelli A, Buoncristiano M, Nardone P (2019) Decline of childhood overweight and obesity in Italy from 2008 to 2016: results from 5 rounds of the population-based surveillance system. BMC Public Health 19(1):618
44. Visscher TL, Heitmann BL, Rissanen A, Lahti-Koski M, Lissner L (2015) A break in the obesity epidemic? Explained by biases or misinterpretation of the data? Int J Obes (Lond) 39(2):189–198
45. Wabitsch M, Moss A, Kromeyer-Hauschild K (2014) Unexpected plateauing of childhood obesity rates in developed countries. BMC Med 12:17
46. Heslehurst N, Vieira R, Akhter Z, Bailey H, Slack E, Ngongalah L et al (2019) The association between maternal body mass index and child obesity: A systematic review and meta-analysis. PLoS Med 16(6):e1002817
47. International Diabetes Federation (2019) IDF Diabetes Atlas, 9th edn. IDF, Brussels, Belgium
48. OECD/Food and Agriculture Organization of the United Nations (2015) OECD-FAO Agricultural Outlook 2015-2024. OECD Publishing, Paris. Available at: https://www.fao.org/3/i4738e/i4738e.pdf. Accessed 28 Mar 2024
49. European Association for the Study of the Liver, European Association for the Study of Diabetes, European Association for the Study of Obesity (2016) EASL-EASD-EASO Clinical Practice Guidelines for the management of non-alcoholic fatty liver disease. J Hepatol 64(6):1388–1402
50. Czernichow S, Kengne AP, Huxley RR, Batty GD, de Galan B, Grobbee D et al (2011) Comparison of waist-to-hip ratio and other obesity indices as predictors of cardiovascular disease risk in people with type-2 diabetes: a prospective cohort study from ADVANCE. Eur J Cardiovasc Prev Rehabil 18(2):312–319
51. Janssen I, Katzmarzyk PT, Ross R (2004) Waist circumference and not body mass index explains obesity-related health risk. Am J Clin Nutr 79(3):379–384
52. Visscher TL, Seidell JC, Molarius A, van der Kuip D, Hofman A, Witteman JC (2001) A comparison of body mass index, waist-hip ratio and waist circumference as predictors of all-cause mortality among the elderly: the Rotterdam study. Int J Obes Relat Metab Disord 25(11):1730–1735

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