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Prevalence of Obesity among Displaced Populations after Exposure to Humanitarian Crises: A Systematic Review

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By

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Bachelor of Science

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2017

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An abstract of

A thesis submitted to the Faculty of the

Rollins School of Public Health of Emory University

in partial fulfillment of the requirements for the degree of

Master of Public Health

in Global Health

2022

Abstract

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Globally, it is estimated that 39% of adults have overweight or obesity. Most estimates fail to account for the prevalence of obesity among displaced populations, especially internally displaced persons (IDPs) and refugees. We summarized the current knowledge of overweight and obesity prevalence among displaced populations and evaluated if subsets of these populations are at increased risk for obesity when compared with local residents and immigrant counterparts. A systematic search was conducted on PubMed, EMBASE, and Web of Science to identify English-language peer-reviewed observational studies published through November 2021. Studies were included if they examined the weight status of displaced populations following humanitarian emergencies and reported overweight and obesity rates. There were no exclusionary criteria for age, gender, country of origin, or resettlement status. A total of 1205 unique studies were identified on PubMed, EMBASE, and Web of Science after deduplication. After following PRISMA guidelines, 80 studies met inclusion criteria. There was great heterogeneity among the studies selected and the displaced populations. These studies were organized into three categories based on residency status. It was found that some populations had higher than 30% of adults having obesity before resettlement and at the time of entrance exams. When compared with adult men, rates of obesity were higher among adult women and higher in older than younger individuals. Adult populations did not show clear increases in overweight or obesity prevalence after resettlement, but when comparing different studies, children (2-18 years of age) increased from 10.2% to 19% in prevalence of obesity after resettlement. Comparing to non-refugee populations had mixed results, but obesity rates were slightly lower among displaced populations when compared to non-refugee controls after resettlement. Overall findings suggest that obesity is an issue displaced population face before resettlement and does not always arise afterwards. While nutrition interventions have been implemented to improve the nutrition needs of displaced populations, most of these efforts have focused on underweight risks. Nutrition efforts need to expand to prevent the development of obesity, particularly among displaced populations before resettlement.

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Acknowledgments

I cannot express enough gratitude to those who have supported me through this process. Many people have helped me to learn and grow as a professional and arrive at graduation with new skills. First and foremost, I need to thank my thesis advisor, Dr. Aguayo-Markes for countless pieces of advice on how to continually improve. Without her, I would have not been able to research a population that is important to me, but moreover, I would have not been introduced to such an important field of research. Her patience and guidance will be with me now as I grow in the public health field. Second, I have to thank other faculty and staff at Rollins and the CDC who have helped answer my questions and inspire me daily to do the best work that I can. Thank you as well to my colleagues and friends at Rollins who always were there to brainstorm or commiserate, and an extra thank you to my roommate Deanna, who was always there with a cup of tea at the end of a long day of writing. Lastly, I must thank my family. My parents have taught me since day one to value my education because it is a privilege. I have not forgotten this lesson even during the long nights; I am grateful to have this opportunity in my life to delve into research. Thank you all!

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Introduction

Obesity has large impacts on public health due to the associations with other noncommunicable diseases (NCDs)[1,2]. Beyond risks associated with NCDs, during the Covid-19 pandemic, obesity was also recognized as an important risk factor for Covid-19, a communicable disease[3]. NCDs have a significant economic impact on healthcare systems[4]. The public health burden and economic impact of obesity has increased as the prevalence of overweight and obesity increase globally [5,6]. In fact, researchers characterize our current era as an "obesity pandemic," illustrating the immediate public health need to address the increasing obesity prevalence.

The nutrition transitions from traditional diets to a reliance on a greater amount of processed foods, and diets rich in fats, meats and sugar, that several countries experienced have been associated with rapid increases in Body Mass Index (BMI)[6,7]. While low and middle-income countries experienced this transition at a later time, and more rapidly than higher-income countries, all countries experienced the subsequent growth in obesity prevalence. Increases in obesity have been documented in males and females of all ages in high-income countries, and primarily among women and middle-aged populations in urban areas of low-income countries[7]. Currently, it is estimated that 39% of adults and 18%of children and adolescents (ages 5-19) have overweight or obesity[8]. However, most of these estimates failed to account for the prevalence risks of displaced populations.

As of mid-2021, there were an estimated 84 million forcibly displaced people globally[9]. Displaced populations have been classified using multiple categories to define their legal status such as refugees or internally displaced peoples (IDPs). Refugees are categorized as populations that have left a dangerous situation like war or other conflict and have crossed borders due to

fear of persecution. IDPs are similar to refugees in the way that they feel unsafe at their place of residence, so they leave. But in the case of IDPs, they stay within the borders and retain the same rights as other citizens. Since both groups are exposed to great stressors like conflict and must relocate, they are exposed to scenarios that can impact their health. In most cases, these populations are exposed to humanitarian emergencies, which consist of crises like epidemics, famine, natural disasters or other emergencies. Further, these populations may be displaced due to complex humanitarian emergencies (CHEs) where the crisis (or crises) are exacerbated by the complexity of the context of the situation. Additionally, movement and resettlement can cause lapses in access to resources. There are currently few solutions to these issues, but many displaced populations either resettle, voluntarily repatriate, or integrate into the local community. In recent years, there have been decreases in the number of people who resettle, and the United Nations High Commissioner for Refugees (UNHCR) estimates that only 20% of their goal was met in 2021[8]. Additionally, most displaced populations now live in urban settings rather than camp settlements, which introduces a different set of health risks. These shifts in living arrangements have been shown to be associated with changes in the risks and prevalence of NCD[10].

Most of the literature examining the health risks of populations that are forcibly displaced focuses on the impact of undernutrition while being displaced. Obesity risks have mostly been examined only after resettlement in high-income countries. However, with this dualistic thinking, gaps may be overlooked especially in IDP populations who may not resettle. Several systematic reviews and meta-analyses on obesity account for certain subsets of these populations, like certain age groups (e.g. only children[11])or populations from certain countries or regions[12]. Yet, the prevalence of overweight and obesity in all age groups of displaced populations that have

been exposed to humanitarian emergencies remains understudied. Since these populations have been exposed to rapid nutrition transitions —as they moved from their place of origin to temporary settlements, and sometimes relocate in higher income countries, it is likely that they are at a higher risk for overweight and obesity than their non-displaced counterparts. This systematic review will examine published research on the prevalence of overweight and obesity in refugees, IDPs, and other displaced populations that were exposed to crises during their lifetime. By not excluding studies based on gender, country of origin, and resettlement status, we can review the overarching picture, and determine if the prevalence estimates of the displaced populations vary from the current global trends. This information can shed light on their current obesity trends and their future risks for noncommunicable diseases, as well as the need for nutrition interventions that aim to lower the burden of obesity among displaced populations.

Methods

Search Strategy

This systematic review was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and was registered at PROSPERO (application pending). The PRISMA framework consists of an iterative process to identify eligible studies[13]. Three databases were chosen; PubMed, EMBASE, and Web of Science to find relevant research. The following key concepts and keywords were used: (1) displaced population or emergency-context terms ("refugee" or "displaced people" or "asylee" or "asylum-seeker" or "humanitarian" or "emergency setting") and (2) weight-related and anthropometric terms ("obesity" or "overweight" or "double burden" or "BMI" or "body mass" or "bodyweight" or "weight gain" or "waist-to-hip" or "waist circumference" or "skinfold thickness"). Search was conducted on November 01, 2021.

Inclusion & Exclusion Criteria

Several criteria for exclusion and inclusion were determined to focus the scope of the systematic review. The first key criterium for inclusion was that the study population had to be only comprised of individuals who were both exposed to humanitarian crises AND were displaced. This included refugees, IDPs, or other special visa holders (SIVs). These populations were included if they had been exposed at any timepoint or were currently experiencing displacement. The second criterium was to have an observational study design that incorporated anthropometric measurements to determine the weight status (e.g. BMI, skin-fold, etc.). Studies that were examining the relationship between the prevalence of overweight or obesity and other disease outcomes were included if weight status results were reported separately. Only peer-reviewed manuscripts published in English and with full text available were included in our review.

We excluded studies that focused on any population that had been exposed to a non-emergency displacement and therefore had different political rights than those of refugees, IDPs, or SIVs (e.g. immigrants or migrants). Additionally, populations who were born to families of refugees after resettlement were not included for not meeting the inclusion criteria. If studies were stratified by these populations, only the data on the originally displaced populations were considered in our review. If research manuscripts did not clearly define which type of displaced population were included, studies were excluded. Clinical trials, intervention designs, and studies focusing on pregnant women and gestational weight were excluded. Other systematic reviews and meta-analyses, scoping reviews, editorials, conference abstracts, and any type of non-peer-reviewed literature were also excluded. In addition, manuscripts that did not distinctly state the

prevalence of overweight, obesity, or overweight/obesity, were excluded. There were no exclusions based on gender, age, country of relocation, or origin country.

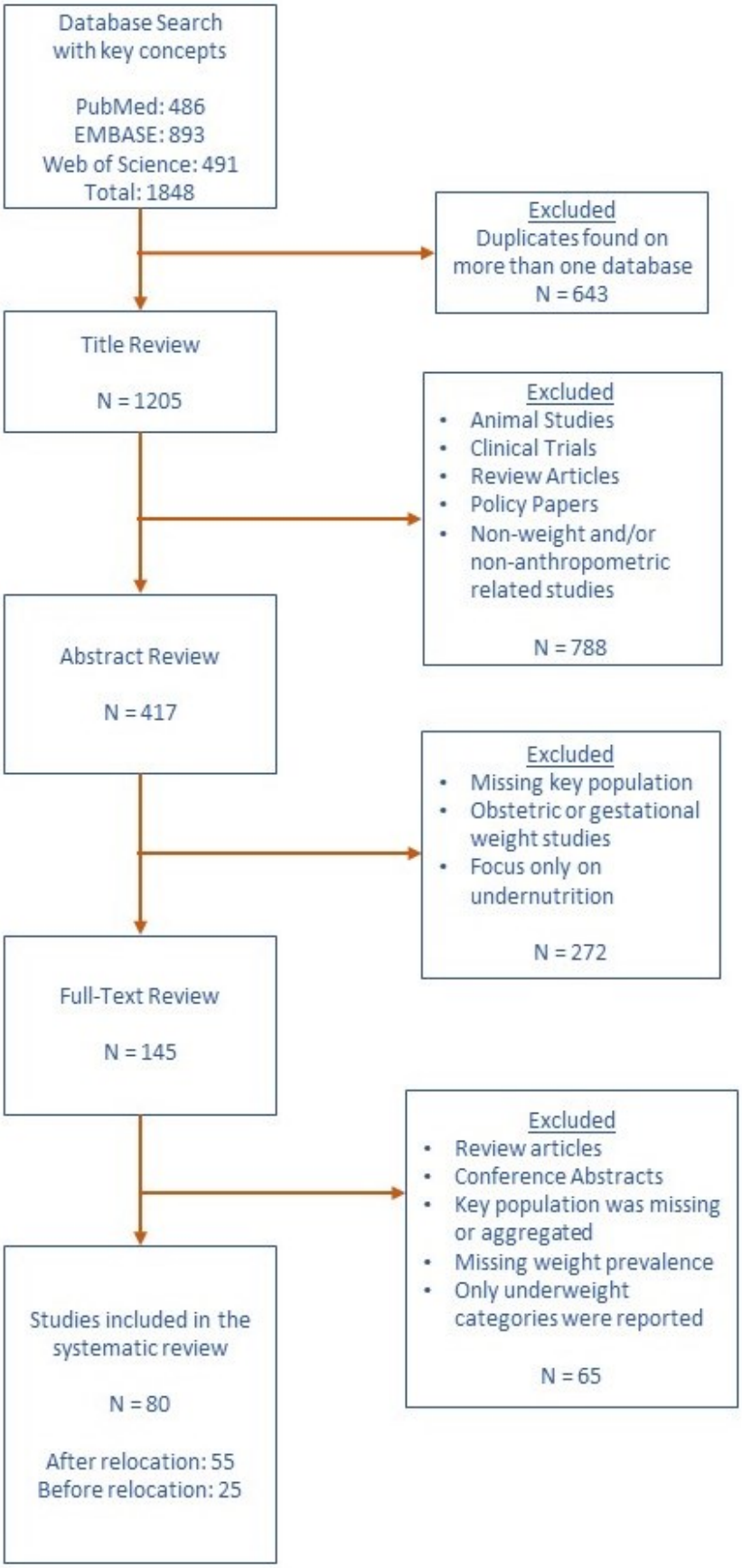
Manuscript Selection

The PRISMA guidelines were followed to find relevant studies. The titles of all potential publications were reviewed after duplicates were removed on EndNote and Covidence. Titles were reviewed for the subject matter and clear indicators of exclusion criteria. After this step, all abstracts were reviewed followed by a full-text review.

Overweight and Obesity Prevalence

In this study, we defined overweight as a BMI of 25-29.9 kg/m^2 and obesity based on a BMI ≥ 30 kg/m^2 for adult populations. For children and adolescents, percentile curves were used for establishing their weight status. In this case, the 85^{th}-95^{th} percentile was considered overweight and over the 95^{th} percentile was categorized as obesity. If studies did not report using these thresholds, for example, using special cutoff points for Asian populations, they were still included in the results with notes discussing these variations.

Figure 1. PRISMA Chart of the data search process



Results

A total of 1205 unique studies were identified on PubMed, EMBASE, and Web of Science (**Figure 1**) after duplicates were removed. After following the PRISMA selection process, 80 studies satisfied inclusion criteria for this review, most of which focus on the effects of resettlement. Multiple studies were excluded from this study because the findings of the displaced populations were not stratified from those of residents or immigrants. Additionally, many papers only reported weight status if it was under the normal threshold – these studies were also excluded. One important distinction in the 80 articles that were selected is that although most used similar sampling methods, only 11 included overweight and obesity status before resettlement. This differentiation will be discussed in more detail in the following sections.

The 80 studies that were included in this systematic review can be found in **Table 1**. Data from the majority of studies included were collected using retrospective chart review (RCR) or completing a secondary data analysis on data on refugee populations (n=27). In total, there were 29 RCRs and eleven longitudinal studies. Other studies comprised of mostly cross-sectional studies. Most cross-sectional studies (n=39) relied on convenience sampling methods especially for the populations that had been resettled and were living in disperse sites. As can be seen in **Table 1**, the study sizes varied greatly. The smallest study, a cross-sectional study on Somali women who had resettled in Australia included 31 participants[14]. The largest study included 358,030 participants identified through an RCR over an eight-year period after resettlement[15]. Due to the different status of these displaced populations, **Table 1** is organized into two sections, with displaced populations that are not resettled being presented first, and populations that have completed resettlement presented second. The first sub-section includes populations that may be politically seen as an internally displaced persons (IDPs) or may be not officially resettled to a

designated reception country. Notably, the terms used to refer to refugee status have changed over the span of these studies from the earliest study dated in 1982[16] to the most recent study published in 2021, shortly before the search of this systematic review was conducted[17].

Table 1 introduces the regional makeup of these studies. The majority of studies that had study populations before resettlement focused on samples from West Asia. Six separate studies took place in Jordan and in Palestine. A few of these studies are comparing different places where refugees are living in settlements and United Nations Relief and Works Agency (UNWRA) sites. Another ten studies wanted to understand the impact of living in urban sites or in settlements on displaced populations. However, more than half of the studies are on populations after resettlement. Out of these, thirty-two focused on populations that resettled in the United States. Two studies of note took place in Sarajevo and Armenia during the 1990s and assessed the nutritional status of an on-going emergency situation. The countries of origin (data not included) were very diverse and included populations displaced throughout the world.

Table 1. Included studies by region, study design, and sample size

Resettlement Status	Country of residence at the time of the study	Study Design	Sample Size (range)
Not resettled at time of study	*Nigeria[18], ***Algeria[19-21], Egypt[22], *Kenya[23]	Cross-sectional (5) Retrospective chart review (1)	65[21]- 3389[20]
	Pakistan[24]	Cross-sectional (1)	206[24]
	Thailand and *Myanmar[25]	Retrospective chart review (1)	**73251[25]
	Iran[26,27], Lebanon[22,28,29], *Palestine[29-33], Jordan[22,29,34-37], Iraq[22,38], Syria[29], *Armenia[39]	Cross-sectional (12) Case-control (1) Retrospective chart review (2)	100[38]- 17632[37]
	Turkey[22,40,41], Greece[22,42], *Sarajevo[43]	Retrospective chart review (2) Cross-sectional (2) Longitudinal (1)	137[41] - **7762[29]
Resettled at time of study	United States[15-17,44-74], Canada[75,76]	Retrospective chart review (15) Cross-sectional (11) Longitudinal (5) Retrospective & longitudinal (3) Retrospective cohort (2)	66[60] - 334,746[15]
	Switzerland[77,78], Germany[79,80], The Netherlands[81], England[82]	Cross-sectional (4) Retrospective chart review (1) Longitudinal (1)	48[78] – 352[77]
	Australia[14,83-89], New Zealand[90-92]	Cross-sectional (3) Retrospective chart review (5) Longitudinal (1)	31[90] – 2992[92]
	South Korea[93]	Cross-sectional (1)	917[93]

Notes: *Studies include populations that may be internally displaced and other non-refugee populations that were not resettled at the time of the study.
** Sample size includes the total number of displaced participants recruited in multiple countries. Subsamples by country were not reported.
***All studies that took place in Algeria are on the Sahrawi people who live in a protracted emergency setting.
Ranges of study samples size only includes the number of participants who attended all follow-up appointments and had BMI measurements. These numbers may not represent the full sample size of each study.

Prevalence of obesity by age and resettlement status

Studies selected were sorted by age groups and presented in three categories by resettlement status in **Table 2**. The first category had studies that focused on populations that had not resettled. These populations were living in IDP, refugee, or other temporary settlements. The second category of studies collected data from initial entrance exams or screenings. In this category, populations underwent an exam shortly before they get transported to the reception country or shortly after resettlement, usually within ~90 days. The third category includes studies after official resettlement. There is some potential overlap between category two and category three because both include populations after resettlement. However, the third category only includes studies that do not specify when the populations were examined or other studies that were assessing effects on obesity prevalence rates after an amount of time after the initial entry. Table 2 introduces the prevalence of overweight and obesity across distinct age categories, but there is some overlap.

Children under five in all resettlement categories had the lowest prevalence of overweight and obesity in comparison to older populations. This trend (obesity increasing with older ages) was observed in all the categories of displaced populations we examined. None of the studies included in this systematic review included data of children under five after the initial medical screening. Studies that included children 2-18 were sorted into the older child category.

Children 5-18 years of age had slightly higher prevalence in comparison to children under five with the exception of a study conducted by Yanni et al. In this study the highest prevalence among children was 14.4% among children under five who were not resettled[37]. Children aged 6-11 years-old had a prevalence of 9.4%, and 12-19-year-olds had a prevalence of 10.2% at entrance exams[37]. The highest values for children and adolescents were seen after the initial

screenings for entry into their reception country. These follow-up times ranged from a few months to years afterwards. Both of the two studies with the highest values examined the longitudinal effect of resettlement in pediatric patients.

Table 2. Prevalence of Overweight and Obesity Status in Displaced Populations by Age

Displaced Population	Overweight prevalence % (age range)	Obesity prevalence % (age range)	Total prevalence % (age range)
Not resettled at time of study[1]			
Children <5 years of age	2.4 - 14.6[20,37,42]	0.6 – 14.4[18,20,37]	4.4 - 15[22,28,34]
Children 5-18 years of age	5- 20[24,32,35,37,41,43]	1.4-10.2[24,32,35,37,41]	17.9[30]
Adults >18 years of age*	24 - 37.8[27,31,37]	19 – 33.5[27,31,37]	60.5-64[31,36,40]
15-44 years	13[27] (15-24)	13[27] (15-24)	43[40] (18-29)
	27[27] (25-44)	25[27] (25-44)	71[40] (30-44)
≥ 45years	29[27] (45-65)	21[27] (45-65)	83[40] (45-59)
	33[27] (> 65)	5[27] (> 65)	82[40] (60-69)
Resettled (Entrance exams)[2]			
Children <5 years of age	5.3 – 8.6[51,87]	0 -6.2[51,87]	NA
Children 5-18 years of age	6.7 -14.5[50,51,55-57]	2.5-7.1[51,55-57,74]	7.1- 25.2 [17,57,71,80,81,85]
Adults >18 years of age	23.2 – 38.3 [15,25,48,49,54,58,59,61,73]	5.9 – 24.6 [15,25,48,49,54,58,59,61,63,64,66,69,73,74]	28.1 – 72.1 [15,54,63,79,86,91]
18-39 years	NA	NA	22[45] (18-28)
			37.2[45] (29-36)
≥40 years	NA	NA	57.2[45]
Resettled (All other lengths of time after resettlement)[3]			
Children 2-18 years of age*	11.5-31[57,67,76]	8.5-19[57,67,76]	21 – 35[17,50,57,71,81]
Adults >18 years of age	20 - 41[48,59,60,72,77,82,88]	8-27.1 [48,53,59,60,69,72,77,82,88]	14.6- 52[60,78]

NA = Not available

Notes: Table represents values that are reported in the selected studies. Some studies did not report total prevalence or did not separate the prevalence of overweight and obesity status.

*Two studies defined adult populations as ≥15 years, but the rest defined adults as≥ 18 years. The two studies who defined adults as ≥15 years were included in the adult category and not in the 5-18 category. Additionally, unless age range is specified, the table introduces the prevalence for the overall age group.

[1]The first category "Not resettled at time of study" is defined as any study that included displaced populations who had not resettled and were not undergoing entrance exams.

[2]The second category "Resettled (entrance exams)" is defined as any study that reported the prevalence of obesity for these initial entrance exams. Initial entrance exams or screenings occur at different time points depending on the reception country. Most displaced populations will undergo an exam shortly before they get transported to the reception country and within 90 days of resettlement.

[3]The third category "Resettled" is defined as studies that examined populations after resettlement, and studies that did not specify the timing elapsed since the entrance into the reception country.

In one of these studies by Olson et al., they reported a prevalence of overweight status at 31% for children who had been living the United states for 6-9 years[67]. At time points higher than nine years, however, the prevalence of overweight decreased below 30%, which is still higher than when children first arrived. The other study by Heney et al., examined weight changes over a span of 3 years with varying numbers of participants[57]. In year three about 35% (n=79) of the children had overweight or obesity at the time of their appointment.

Patterns of overweight and obesity in the adult populations by resettlement status are presented in **Table 2**. Prevalence of overweight or obesity is higher among adults than children or adolescents. This was consistently found in the three-resettlement classifications examined. A study of US-bound refugees from Burma by Bardenheier et al. reported the lowest prevalence rats of obesity. During entrance exams the average obesity rates (with obesity cutoffs of BMI ≥ 27.5) among adults was 5.9% over an eight-year period[25]. This value is smaller to rates reported by studies done after resettlement, and is noticeably smaller than the mean rates observed among displaced populations that were not resettled at the time of the study which was 19%[27]. Prevalence rates were similar in displaced populations that had not resettled and those examined during entrance exams. About 37.8% of adults not resettled had overweight[31] and 33.5% had obesity[37]. Meanwhile, about 38.3% of adults examined during entrance exams had overweight[59] and 24.6% had obesity[74]. Notably, all of these studies were examining displaced populations from Palestine or Iraq.

Two studies reported the overweight and obesity prevalence as one total value for displaced populations who had been resettled for some length of time. This range of prevalence rates of 14.6-52% was lower than the population that had resettled as well as entrance exam data[60,78]. This is in contrast where the overall overweight and obesity prevalence rates were higher after

resettlement for a length of time in children and adolescents. A few of the studies on adults also stratified the adult population by age, using ten-year increments. Findings from these studies suggest that the prevalence increased from the younger strata to the older ones[40]. In contrast, Taherifad et al., found that the lowest prevalence of obesity was in the >65 and older sub-group, with prevalence rates similar to those found in younger populations, such as children under five.[27] Stratification by age does not seem to follow distinct patterns with the exception that children and adolescents had lower prevalence, but it is inconclusive whether prevalence rates increase or decrease with age.

Prevalence of obesity by sex and resettlement status

Several of these studies in this systematic review only looked at either female or male populations or stratified their samples by sex. **Table 3** introduces the prevalence rates by sex. For this analysis we used the same categories introduced in **Table 2**, and children and adults were also stratified. **Table 3** suggests rates of overweight and obesity were similar among males and females in all the three settlement categories. Only slight differences were observed with females exhibiting higher rates when compared to adult male populations. This trend was found among adults before and after resettlement.

Studies that focused on populations with chronic diseases like Metabolic Syndrome (MetS) and diabetes reported higher obesity rates. For example, a study by Leone et al., that focused on women who have not resettled and had diabetes found prevalence rates of 80% among women[21]. Disease status was not an exclusionary criterium in this systematic review. Men were often not included in these studies, and other comparison groups were not involved. If studies that included women and men with MetS and diabetes were excluded, the ranges of overweight or obesity prevalence rates before resettlement would be 20.5[43] – 64.5%[19] for women and 12.1[43] –

68%[40] for men. These rates are similar to the prevalence of obesity of 20.5-80% documented among women with chronic diseases, who were not displaced.

Table 3. Prevalence of Overweight and Obesity Status in Displaced Populations by Sex and Age

Displaced Population	Overweight prevalence %	Obesity prevalence %	Total prevalence %
Not resettled at time of study			
Female	*1.3-16.3*[18,24,38] 20.3-35.4[19-21,26-28,31,33,39]	*0-11*[24,38] 11.8-47.4[19-21,26-29,39]	*10 - 18.9*[22,30,43] 20.5-80[20,21,26,31,33,40,43]
Male	*0-20*[18,24,38] 6-28.9[19,23,27,31]	*3.4-10*[24,38] 0.4-29.7[19,23,27,29,62]	*13 – 32.3*[22,30,43] 12.1-68[31,40,43]
Resettled (Entrance Exams)			
Female	*13.7*[80] 20[86]	*8.8*[62] 17 -20 [16,62]	*2.7- 18.3*[62,71] 10.3 – 55.1[45,62,83]
Male	*5.4*[80] 28[86]	*8.6*[62] 0 – 9.5[16,62]	*8.8 – 28.6*[62,71] 6.9 - 41[45,62,71,83]
Resettled (Other lengths of time)			
Female	NA 21.5 – 44.4[46,52,77,90,93]	*12.1*[62] 6-35.7[46,52,62,68,77,90,93]	*8.8 – 42.9*[62,71] 52.8 – 73.5[14,46,47,62,68,79,90]
Male	NA 26.5 - 30.4[77,93]	*13.3*[62] 5.4 – 22.6[62,77,93]	*5.9 - 40*[62,71] 49.6 – 58.6[62,79]

Notes: Italicized percentages represent the prevalence of overweight and/or obesity status in children (<18). NA – not applicable

There were important differences by sex in the prevalence of overweight and obesity at the third categorical level, among individuals who had resettled for some length of time. The prevalence of the overweight and obesity rate among men ranged from 49.6% to 58.6%, whereas overweight and obesity prevalence among women ranged from 52.8% to 73.5%. Notably, the higher overweight or obesity prevalence rate for women was higher at 73.5% in comparison to men at 58.6%[62]. Both of these higher prevalence rates were found in the same study by Mulugeta et al, on displaced populations from a mixture of locations resettling in the United States for more than a year[62].

Very few studies included children. When aggregated, overweight or obesity rates in children before resettlement ranged from 10-18.9% in girls and from 13-32.3% in boys, and the rates are similar in the second category with the ranges being 2.7-18.3% and 8.8-28.6% respectively[22,30,43,62,71]. These prevalence rates increased after resettlement, where overweight or obesity rates reported were as high as 42.9% for girls and 40% for boys[71]. In a study by Shapiro et al., the weight trajectory of children was studied after resettlement to the United States[71]. This study stratified children by country as well as sex and found that Iraqi refugee children had the highest values at their final visit when 42.9% (n=7) of boys and 40% (n=15) of girls had overweight or obesity[71]. Children from Burma and Bhutan showed lower prevalence rates ranging from 8.8% to 26.3% (not introduced by sex). When compared to the obesity rates of children before resettlement, rates of children from Burma and Bhutan were similar, whereas obesity rates of refugees from Iraq were much higher.

Prevalence of obesity among displaced populations in comparison with non-displaced populations

Several studies examined refugee populations in comparison to similar populations, which can be examined in **Table 4**. Some used matched controls while other research was more focused on how BMI compared to regional data. Three studies compared refugees while they were living in settlements to other groups and found few significant differences.

Table 4. Prevalence of overweight and obesity status in displaced populations compared to nondisplaced populations

Comparison	Refugee Populations Overweight/obesity/(total) %	Comparison Group Overweight/obesity/(total) %	95% CI or p-value
Refugees vs. residents	Attend UNWRA schools 12.8/7.3	Attend government schools 12/4.5	0.8-1.4/1.1-2.5[32]
	Syrian refugees (Urban) 5/7.5 Syrian refugees (TPC) 15.4/6.2	Turkish citizens (Urban) 2.5/11.2	NA[41]
	Refugees in Sarajevo 20 (Total time 1) 18.5 (Total time 2)	Residents of Sarajevo 10.1 (Total time 1) 15.1 (Total time 2)	NA[43]
	Palestinian refugees Jordan – 32.7 (M) 53.7 (F) Lebanon – 22.4 (M) 38.7 (F) Gaza – 34.1 (M) 41.6 (F) West Bank – 28.7 (M) 52.6 (F) Syria – 25 (M) 42.7 (F)	Host country population *Jordan – 10.3 (M) 16.2 (F) *Lebanon – 14.3 (M) 18.8 (F) *Palestine – 30 (M) 50 (F) *Syria – 28.8 (M) 46.4 (F)	NA[29]
Resettled refugees vs. Other migrating populations	Refugee 36.7/18.2	Other incoming groups family reunion - 32.4/11.4 employment - 31.2/6.4 diversity - 28/6.8 legal - 45.1/25.6	All weight statuses were "significant" including under[72]
	Refugees 11.5/8.5	Immigrants 19.1/12.2	Not significant[76]
Resettled refugees vs. Residents of reception countries	Resettled Somali women 35.7/ 35.7/71.4	New Zealand women 30.1/19.2/49.3	0.46/0.01/0.01[90]
	**Vietnamese Population M 6.9 F 10.3	**Australian population M 48 F 33.5	< 0.0001[83]
	Refugee clinic total 52	Bhutanese population*52 US population* 68.2	NA[60]
	Adult Iraqi refugees /24.6	Adult US Residents /24.8	NA[74]
Resettled refugees vs. Non-Refugee controls	Refugee children 7.8/--	Non-refugee children 32.1/--	Nutritional status overall <0.001
	African refugees --/13.5 (BL) --/20.5 (Y1) --/27.1 (Y5)	Regional non-refugee --/30.2 (BL) --/43.3 (Y1) --/41.4 (Y5)	0.002[69] 0.0001[69] 0.002[69]
	Refugees 32.9	Control group 51.3	P=0.01[17]

Green – value is similar, Blue – value is lower, Yellow – value is higher

TPC – temporary protection center, UNWRA – United Nations Relief and Work Agency for Palestinian Refugees in the Near East, US – United States, M- Male, F – Female, BL- Baseline, Y1 – year 1, Y5 – year 5

*Indicates comparison group values are from external surveys like nationwide health surveys unless significance level is provided.

** Indicates percentage of population that had BMI over 25 (overweight or obese).

Syrian refugees living in temporary protections centers had higher rates of overweight than urban Syrian and local Turkish populations[41]. Smaijkic et al., found that during the protracted Bosnian War, refugees in Sarajevo had higher rates of overweight than non-refugee residents of Sarajevo[43]. The two studies that compared refugee visa holders to either immigrants or other visa holders in North America[72,76], found that there were not significant differences in overweight and obesity rates. The only distinction was that there were more refugees who have obesity when examined against other visa holders[72], although significance was not determined.

Overall, studies of the differences in overweight and obesity rates between residents of the reception countries and displaced populations yield inconsistent results. A Morbidity and Mortality Weekly Report (MMWR) on Iraqi refugees compared to United States residents had similar rates of obesity. Additionally, a study by Kumar et al., found that the obesity prevalence of refugees in the United States was similar to the overall obesity prevalence in Bhutan but lower in comparison to United States residents[60]. In contrast, one study found that Vietnamese refugees had a lower prevalence in comparison to Australian residents,[83] while a study comparing Somali women to residents of New Zealand found a higher obesity prevalence[90]. However, when controls were matched to the refugee samples, prevalence rates of overweight and obesity were lower among refugees in a trend over a five years period[69]. Rhodes et al., found that when compared with an American control group, prevalence of obesity was lower among refugees, but the increase in overweight status increased at a faster rate among refugees[69]. In this study, the prevalence of overweight and obesity for refugees was nearly half of the prevalence of overweight and obesity in Americans[69].

Differences in prevalence of obesity with changes in resettlement status

While evidence is limited, studies that examined changes in obesity rates longitudinally suggest rates increase with time after resettlement. Rhodes et al., found that although the obesity rates of displaced populations were lower than the rates of their local counterparts in the resettlement country[69]. These rates of displaced populations increased over a period of five years after their resettlement[69]. Several studies have also observed this increase over longer periods of follow-up time[48,57,59,71,81]. For example, Catherine et al., found that rates of obesity among displaced populations increased significantly by 0.27 two-years after resettlement. ($p<0.0001$)[48]. Conversely, Chernet et al., observed an increase in overweight rates from 70.7 to 75% but saw no increase in obesity at 14.6% after following a sample of displaced adults for one year after their resettlement[78]. In a more nuanced way, a couple of studies examined how the study participants' BMI classification changed over time. One study found that in pediatric refugee patients that most saw no change, but about 7% of children had normal weight and then had overweight or obesity after a period of two years since resettlement[55]. Mulugeta et al., instead, found similar increases in overweight or obesity in both children and adults [62]. And finally, Bardenheier et al., found a significant increase in obesity rates over eight years among Burmese refugees after they entered the United States[25].

Discussion

This review evaluated the prevalence of overweight and obesity status in displaced populations that had been exposed to humanitarian emergencies. One of the objectives of this review was to examine how the prevalence rates among populations forcibly displaced compared to rates of non-displaced populations. Of the 80 studies that satisfied our eligibility criteria, 25 examined weight status before resettlement and 55 examined weight status after resettlement. For our

analyses, studies were classified by resettlement status in three categories: 1) Populations that have not settled at the time of the study, 2) populations undergoing entrance exams in order to resettle, and 3) populations who have resettled for extended periods of time. The studies that focused on internally displaced populations (IDPs) or refugees before resettlement mainly consisted of cross-sectional studies whereas the studies from after that period of resettlement mostly analyzed the measurements taken at initial entrance examinations. Weight and height examinations are requirements for travel and are followed up within a few months of resettlement. Thus, although the requirements and examinations vary by country, all included studies had anthropometric measurements and body mass index (BMI) measurements.

Overall, the prevalence rates of obesity ranged from zero, in a study conducted among children under five, to over 30%, in a study conducted among adult Iraqi refugees[51,87]. We found that overweight and obesity were present across the lifespan. As with non-displaced populations, overweight and obesity rates increased with age, and were not health problems that develop *only* after resettlement. Among adults, prevalence rates were higher among populations that had not resettled than populations that had resettled for a period of time. However, these higher rates may be explained by the increased focus on populations that had chronic diseases like diabetes or metabolic syndrome as compared with sample of only healthy adults. Chronic diseases were unknown or were not specified in the studies that took place after resettlement, so direct comparisons could not be made.

In a meta-analysis by Baauw et al., the prevalence of overweight and obesity in refugee children (0-18 years) who were receiving entrance exams after resettlement, was estimated. This study found that 10.8% (95% 7.6-14.3) of children had overweight and 5.7% (95% CI 1.9-11.4) had obesity upon entry into reception countries; we categorize this period as comparative to the

second category of populations with entrance exam data. While this systematic review introduced two age categories for assessments of children under five and 5-18 years of age, the prevalence estimates from Baauw et al. are similar to the prevalence ratios we identified among children who are not resettled (including IDPs & Palestinian populations) as well as children upon completion of entrance exams. Although the meta-analysis by Baauw et al. focused on children after resettlement exclusively, it suggested that there is an issue with overweight and obesity before these vulnerable populations have lived in reception countries for a length of time. Our findings agree with these findings and highlight the need to monitor overweight and obesity risks among all displaced populations.

When separated by sex, most children (< 18 years), had similar overweight or obesity prevalence rates with their opposite sex counterparts. Only two studies identified sex differences in childhood obesity rates. In a study of newly resettled Syrian refugee children, prevalence of overweight at the entrance exam was 13.7% among female children, and 5.4% in male children[80]. In a second study among refugee children resettling from a variety of regions into the United States, 28.6% of male refugee children aged 2-18 years had obesity, as compared with 18.3% of female children at the time of their entrance exams[62].

There were also differences by sex observed among adults. When compared with men, prevalence rates appear to be higher among women (>18 years) both before resettlement and after. For example, in the same study as previously mentioned that studied longitudinal changes in weight status after resettlement,20% of women had obesity at the time of their entrance exams in comparison to 9.5% of men, which is nearly double. Cooper et al., explored gender differences in obesity prevalence in various countries without disaggregation of residents and displaced populations. Most countries showed a higher prevalence of obesity in women in comparison to

men and the authors described how obesity prevalence rates change depending on the region and where they are within the "obesity transition[94]." The authors also argue that aspects like cultural norms and differences in adiposity may lead to this difference in overweight or obesity prevalence[94]. Displacement was not discussed in this research, but the countries included were representative of the reception countries (i.e. Turkey, Germany, etc.) and countries where the displaced populations originated (i.e. Thailand, Ethiopia, etc.). As the Internal Displacement Monitoring Centre states, although women and girls only make up a little over half of displaced peoples, the proportion of women is often higher because men might not be able to leave.[95] This suggests that the burden of overweight and obesity in displaced populations might be higher among women than the national population.

Studies that compared prevalence of overweight and obesity of refugees with rates of non-displaced residents of the countries where they were living temporarily, revealed important differences. When compared with local non-refugees, refugees in Sarajevo had nearly double the overweight rates[43]. Similarly, Palestinian refugees in Jordan and Lebanon had two to three times the prevalence rates of their non-displaced Jordan and Lebanon counterparts[29]. In the United States, refugees had a higher prevalence of obesity in comparison to other types of incoming non-refugee populations who had been resettled[72]. However, the obesity prevalence rates are not disaggregated by how long the group had been in the United States[72]. In a different study, refugees (ages 3-13 years) from multiple regions had similar prevalence rates of obesity in comparison to immigrants who had migrated into Canada in the previous five years[76]. Overall, there was no conclusive distinction when comparing obesity risks of refugees with prevalence of residents at the reception countries. This might partially be because of the heterogeneity in the

populations of both refugee and recipient countries, and assessment of refugees from a singular ethnicity in comparison with the reception country's more diverse population.

The most conclusive trends observed was in studies comparing resettled refugees with non-refugee controls. In all three studies, the non-refugee controls had higher prevalence rates. While these findings recognize the largest burden of overweight and obesity was not observed among refugees when compared with non-refugees over a period of time, it is important to recognize that prevention of overweight and obesity among refugees should still be considered a public health concern.

To address one of the main gaps in the literature, this systematic review focused solely on displaced populations but excluded migrants and immigrants. This exclusion allowed the review to focus on the potential risk of obesity after exposure to a humanitarian emergency. Prior reviews that focused on the changes in obesity prevalence in differing populations like migrants and immigrants, have recognized an increasing obesity risk associated with higher levels of acculturation to the culture of the host high-income countries[96,97]. However, these studies have also noticed nuanced differentiations between societal factors like social norms[96,98].

To our knowledge, this is the first systematic review to examine the risk of overweight and obesity among adult displaced populations before *and* after resettlement. Another strength of our review is the inclusion of several studies with robust evidence form large sample sizes, and high-quality randomized studies. Further, several studies were conducted at IDP settlements using clusters and randomized sampling which introduces stronger evidence. By including IDP populations we were able to draw conclusions that previous systematic reviews had not been able to observe. While we are limited in the comparisons we can make given the heterogeneity of the displaced populations, this study relied on body mass index (BMI) measurements, which are

universally examined with standardized metrics and cut-off criteria. BMI is routinely measured across clinical and non-clinical settings with high levels of precision and accuracy, increasing the strength of the findings reported. This is particularly relevant when considering health assessments of displaced populations that are limited by the barriers to access healthcare resources, and contextual challenges.

Notably, this study has several limitations that need to be recognized. Most studies included in this review were cross-sectional and relied on retrospective chart reviews. This type of study design has major limitations and does not allow researchers to determine if obesity risks of displaced populations changed with shifting resettlement status. Using retrospective chart reviews can also introduce error since the methodology of the appointments or screenings cannot be standardized. Additionally, a large number of included studies utilized convenience sampling when recruiting populations after resettlement. This approach reduces generalizability. Further, we did not limit our timeframe to a specific birth period, which introduced well-known cohort effects. Given the heterogeneity of the populations and studies included we were not able to assess the quality of the included studies. We also did not account for different sources of bias that could be associated with differences in study design and methodology, for example, sample size, sampling frame, recruitment location, adjustment for potential confounders, potential for measurement errors, and other sources of bias. Moreover, our analysis is not representative of all displaced populations, and the extent to which findings are under- or overestimating the obesity prevalence is unknown.

Being underweight and experiencing severe acute malnutrition are life-threatening conditions with lifelong health consequences, including mortality. Thus, it is understandable that in the acute phase of emergencies, risk for underweight is prioritized. However, the long-term effects

of obesity also have life-long negative consequences. For example, obesity is associated with multiple noncommunicable diseases like diabetes and cardiovascular diseases. As humanitarian emergencies shift towards protracted situations and more displaced populations settle in urban environments, the obesity risks of these populations need to be monitored. In this systematic review, several studies found that a large proportion of the displaced adult populations have overweight or obesity, with some studies reporting overweight or obesity among nearly half the sample[31,36,40,60]. These high rates were found among adults in both, not resettled and after resettlement conditions and ranged from 52-64%. These populations consisted of displaced Palestinians, Iraqi refugees, and Syrian refugees who had not resettled, as well as Bhutanese refugees who had resettled in the United States. With such a large proportion of the population being affected by obesity, obesity-related comorbidities are an increasing concern. Our findings suggest that obesity is an issue before resettlement and not just after resettlement into a higher-income setting. Additionally, we found that not all refugees had higher obesity prevalence when compared to residents, indicating that the health needs of displaced populations may differ from the populations in which they resettled. Previous reviews focused on populations that have decided to resettle and have completed their settlement process successfully. From our results, we show that this may not be the only time that monitoring is necessary, in fact, it is recommended to monitor and prevent weight gain before overweight and obesity develop, which our findings suggest is likely before entrance exams are conducted.

The variation between age groups and contexts in this systematic review illustrate that overweight and obesity is an issue in displaced populations that should be contextualized. Most research in the past focuses on the risk of increased BMI after resettlement, but this is not the only context where the prevalence of overweight and obesity may be a concern. Moreover, those

approaches ignore the needs of a large proportion of displaced populations who may never resettle, especially to a setting that is demographically particularly different from where they had been living previously. At this time, there are gaps in the literature on the impact of overweight and obesity in displaced populations that have not resettled. Longitudinal studies are needed to better understand changes in weight status over time and across different stages of resettlement. Although general trends could be seen in this systematic review, further research is needed to examine trends in weight gain and obesity risks by location of origin and resettlement destination.

In conclusion, this systematic review points to the large burden of overweight and obesity in displaced populations of all ages. Findings highlight the need to prioritize obesity prevention alongside current underweight and malnourishment efforts after the acute onset phase of emergencies.

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