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META-ANALYSIS

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Prevalence of underweight in people with severe mental illness: Systematic review and meta-analysis

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Abstract

People with severe mental illness (SMI) have a higher prevalence of obesity as compared with the general population, however, there is mixed evidence about the prevalence of underweight. Thus, the aim of this study is to determine the pooled prevalence of underweight in people with SMI and its association with socio-demographic factors; and to compare the prevalence of underweight between SMI and the general population. MEDLINE, PsycINFO, and EMBASE databases were searched to identify observational studies assessing the prevalence of underweight in adults with SMI (schizophrenia, major depressive disorder with psychotic features, and bipolar disorders). Screening, data extraction, and risk of bias assessments were performed independently by two co-authors, with disagreements resolved by consensus. Random effect estimates for the pooled prevalence of underweight and the pooled odds of underweight in people with SMI compared with the general population were calculated. Subgroup analyses were conducted for the type of SMI, setting, antipsychotic medication, region of the world, World Bank country income classification, data collection, and sex. Forty estimates from 22 countries were included. The pooled prevalence of underweight in people with SMI was 3.8% (95% confidence interval [CI] = 2.9–5.0). People with SMI were less likely to be underweight than the general population (odds ratio [OR] 0.65; 95% CI = 0.4–1.0). The pooled prevalence of underweight in SMI in South Asia was 7.5% (95% CI = 5.8–14.1) followed by Europe and Central Asia at 5.2% (95% CI = 3.2–8.1) and North America at 1.8% (95% CI = 1.2–2.6). People with SMI have lower odds of being underweight compared to the general population. People with schizophrenia had the highest prevalence of underweight compared to other types of SMI. Japan and South Asia have the highest prevalence of underweight in people with SMI.

KEYWORDS

bipolar disorder, schizophrenia, severe mental illness, systematic review, underweight

Bilal Ahmad Khan and Humaira Khalid contributed equally to the writing of the manuscript.

1 | INTRODUCTION

Severe mental illness (SMI) includes schizophrenia, major depressive disorder with psychotic features and bipolar disorders (Evans et al., 2016). People with SMI have a high prevalence of physical health conditions and increased mortality (Firth et al., 2019; World Health Organization, 2018). The mortality rate is three times higher among people with SMI compared to the general population (De Hert et al., 2009; Vancampfort et al., 2015). Both obesity and underweight have a negative impact on health and well-being as illustrated by the *U*-shaped association between body mass index (BMI) and mortality with both obesity and underweight being associated with increased mortality (Berrington de Gonzalez et al., 2010). Underweight is associated with micronutrient deficiencies, impaired immune response, osteoporosis, and asthma (Popkin et al., 2020), and recent studies (D. Park et al., 2017) show that being underweight is a risk factor for cardiovascular disease. Conversely, those with severe physical illnesses such as cancer (American Cancer Society, 2020), diabetes, hyperthyroidism (Kresimira, 2009), and tuberculosis (Hira et al., 1998) are more at risk of being underweight.

The prevalence and determinants of obesity in people with SMI have been studied (Afzal et al., 2021; Firth et al., 2019; Vancampfort et al., 2015; World Health Organization, 2018). However, there is more limited evidence about the prevalence of underweight and its determinants. Genetics, metabolism, lack of food, poor appetite, and drug and tobacco use have all been proposed as possible mechanisms potentially linking underweight with SMI (Sugawara et al., 2018). A number of studies (Inamura et al., 2012) in people with schizophrenia in Japan have consistently found a high prevalence of underweight in this population. In contrast, a meta-analysis (Sugawara et al., 2018) of 17 studies of underweight in schizophrenia including other regions of the world reported mixed findings, with both higher and lower rates compared with the general population. Considering the lack of reviews on underweight including other types of SMI such as bipolar disorder and severe depression, rapid changes in health risk behaviors across the world, and the increasing number of studies evaluating the physical health of people with SMI, an up-to-date synthesis of the literature to estimate the prevalence of underweight in SMI is needed. This could help clinicians and policymakers understand the trends of underweight and identify groups that might be at higher risk (i.e., region of the world, type of SMI, sex).

We conducted a systematic literature review and meta-analysis to assess the prevalence of underweight in people with SMI. More specifically, our aims were (1) to determine the overall pooled prevalence of underweight and prevalence by type of SMI, setting, geographical region, country economy classification, year of data collection, and sex; and (2) to assess the likelihood of underweight in people with SMI compared with matched controls from the general population.

2 | MATERIALS AND METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et al., 2009) and Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines (Stroup & for the Meta-analysis Of Observational Studies in Epidemiology MOOSE Group, 2000). The protocol has been registered and published in the International prospective register of systematic reviews (PROSPERO) *CRD-42020200380* (Afzal et al., 2020). The protocol includes prevalence of overweight and obesity, the results for which are published in a separate manuscript (Afzal et al., 2021).

2.1 | Search strategy

We conducted a systematic search of MEDLINE, PsycINFO, and EMBASE databases. Studies that were published from the date of inception up to July 2020 were included. Combining the following keywords, the search terms used were (1) Population ("serious mental illness" OR "severe mental illness" OR "psychosis" OR "schizophrenia" OR "psychotic disorder*" OR "psychosis" OR "psychotic" OR "schizo-affective" OR "schizoaffective" OR "manic" OR "bipolar disorder*" OR "mania" OR "bipolar" OR "major depressive disorder" OR "depression" or "antipsychotic"); (2) Outcome ("Body Mass Index" OR BMI OR "waist circumference" OR weight OR "percentage body fat" OR "waist to hip ratio" OR underweight OR undernourished* OR thinness OR undernutrition * OR malnutrition* OR adiposity); (3) study design (cross-sectional* OR "cohort" OR epidemiology OR prevalence OR observant OR observational OR longitudinal OR survey OR case-control). In addition to that, we conducted citation searches for studies that were included and related systematic reviews to identify any significant additional studies.

2.2 | Study selection

For the systematic review and meta-analysis, studies were included according to the following criteria:

(1) Studies included a diagnosis of SMI (bipolar affective disorder, schizophrenia, and major depressive disorder with psychotic features) including adult populations (aged ≥18 years), using the definitions of standardized assessment tools such as the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 2013), or the International Classification of Diseases (ICD; World Health Organization, 1993);
(2) Studies which estimated the prevalence of underweight using BMI, applying any established, standardized definition of underweight, i.e., the WHO criteria (OECD/WHO, 2020; WHO Expert Consultation, 2004);

(3) Any observational studies (such as retrospective or prospective cohort studies, cross-sectional and case-control studies).

Studies with populations under 18 years of age, qualitative studies, and those studies with a sample size below 30 were excluded. Initially, our search strategy had no language restrictions, however at the full-text screening stage due to resource restrictions we excluded papers if they were not in English.

2.3 | Outcomes

The primary outcome was the prevalence of underweight among people with SMI.

Secondary outcomes were the prevalence of underweight from matched controls from the general population (when available).

2.4 | Data extraction (selection and coding)

Data selection and screening were completed using Covidence (2016). Two independent authors (H. K. and M. A.) completed the title and abstract and the full-text screening; disagreements were resolved by consensus and consultation with a third and fourth independent author (G. A. Z. and B. A. K.). The full text was retrieved for articles that were considered eligible and those with insufficient information from the abstract.

One author (B. A. K., R. A., M. A., S. R., or H. K.) extracted and reviewed data for each included study by using a pre-designed data extraction form. The details included: title, authors, study design, year of data collection, sample size, geographical region according to World Bank region classification (Fantom & Serajuddin, 2016), study settings (community-based, inpatient, and outpatient), country income classification (high-income countries [HIC] or low and middle-income countries [LMIC]) according to World Bank (Fantom & Serajuddin, 2016), the prevalence of underweight by gender as compared to the general population, BMI criteria of classification and prevalence of underweight, use of antipsychotic medications (open SMI population vs. antipsychotic-naive cohort) and diagnosis criteria of SMI.

We also extracted the prevalence of underweight by sex and for matched controls from the general population from the available studies. For papers that reported data of the same study, we selected the paper with the most recent date of publication and with the largest sample size (if the sample size was the same). In papers that reported data independently for different countries or SMI conditions, data were separated and the underweight estimates were considered as independent studies.

2.5 | Risk of bias

Two independent authors (G. A. Z. and S. R.) evaluated the quality of included studies following the criteria of Joanna Briggs Institute *Critical Appraisal Checklist* (Munn et al., 2020). The Cochrane Risk of Bias tool (Higgins et al., 2019) was used to carry out the overall risk of bias assessment. Studies were considered as: "low risk of bias" if all domains of the tool were scored as "yes" or only one domain was marked as "unclear"; "medium risk of bias" if two or three domains were marked as "unclear"; and "high risk of bias" if there were four or more domains marked as "unclear" or at least one of them was marked as "no" (Lundh & Gøtzsche, 2008).

2.6 | Data analysis

2.6.1 | Descriptive analysis

Characteristics of eligible papers were summarized, providing information on the number and frequency of studies according to the World Bank income classification, the World Bank geographical region, type of SMI (schizophrenia, bipolar disorder, or a combination of SMI operationalized as "any"), the diagnostic tool to define the SMI, the study design, year of data collection, BMI classification, gender, and overall risk of bias. Using standard procedures (Spineli et al., 2015), we imputed the year of data collection, whenever this information was not available.

2.6.2 | Meta-analysis

To account for the high heterogeneity that was expected between the studies, we used random effect models. The first analysis determined the pooled prevalence of underweight. The second analysis was used to determine the odds of people with SMI of being underweight compared with matched controls from the general population. The third analysis was used to determine the odds of women with SMI being underweight compared with men with SMI. For the second and third analyses, we used those studies with data available on underweight for matched control from the general population independently.

2.6.3 | Sensitivity analyses

To assess the reliability of the results, multiple sensitivity analyses were performed. First, "high risk of bias" studies were removed from the analysis. The studies which had different cut-off points for underweight from WHO classification were then removed for the second analysis. And lastly, for the overall high-income analysis, we removed those studies where data were incomplete.

The pooled prevalence of underweight was mapped by country in a world map. A weighted mean was calculated for countries with more than one study by using data from all the available studies. The R world-map library in R V4.1.1 (R Core Team, 2020) was used to generate maps.

3 | RESULTS

As shown in Figure 1, after excluding 720 duplicate records, we screened 12,653 papers, of which 725 were screened for full text. We separated the estimates of underweight for each country/region for one paper (S.-C. Park et al., 2020) that provided estimates from five South Asian countries; one paper (Post et al., 2014) that reported estimates from Europe and the United States; and one paper (Zavala et al., 2020) which provided estimates from Bangladesh and Pakistan. This meant from a total of 34 records, we extracted 40 independent estimates of underweight (Table 1).

Table 1 shows the characteristics of the studies included in the meta-analysis. The sample size of the studies ranged from 46 to 19,678 with a mean of 1478 participants. More than 60% of the studies were classified as having "low" risk of bias, 20% as "medium risk" and 17.5% as "high risk" (Table 1). The age of participants ranged from 24 to 61 years, with a mean age of 43.6 years. More studies were conducted in HICs as compared to LMICs. More than 50% of the studies used DSM-5 (American Psychiatric Association, 2013) or ICD-10 (World Health Organization, 1993), while majority used the WHO international classification of BMI (OECD/WHO, 2020) to define underweight (<18.5 kg/m^2), with the other 10% (Anuurad et al., 2003; Chobanian et al., 2003; Takimoto et al., 2004) using ethnicity adjusted classifications, which usually have a lower cut off value. As shown in Table 2, the pooled prevalence of underweight was 3.8% (95% confidence interval [CI] = 2.9–5.0; n = 59,127), with a heterogeneity of 98.2%, and T^2 = c 0.7159, p < 0.01. The pooled prevalence in LMICs was higher than HICs. A substantial difference was identified among SMI diagnoses; such that the pooled prevalence of underweight in people with schizophrenia was highest for people with bipolar disorder, and the pooled prevalence for people with any disorder at was lower. We also found that number of inpatients was higher than outpatients (Figure 2).

As shown in Figure 3, there were considerable country differences in the pooled prevalence of underweight, with the highest prevalence in Japan (16.4%), and the Czech Republic (14.1%),

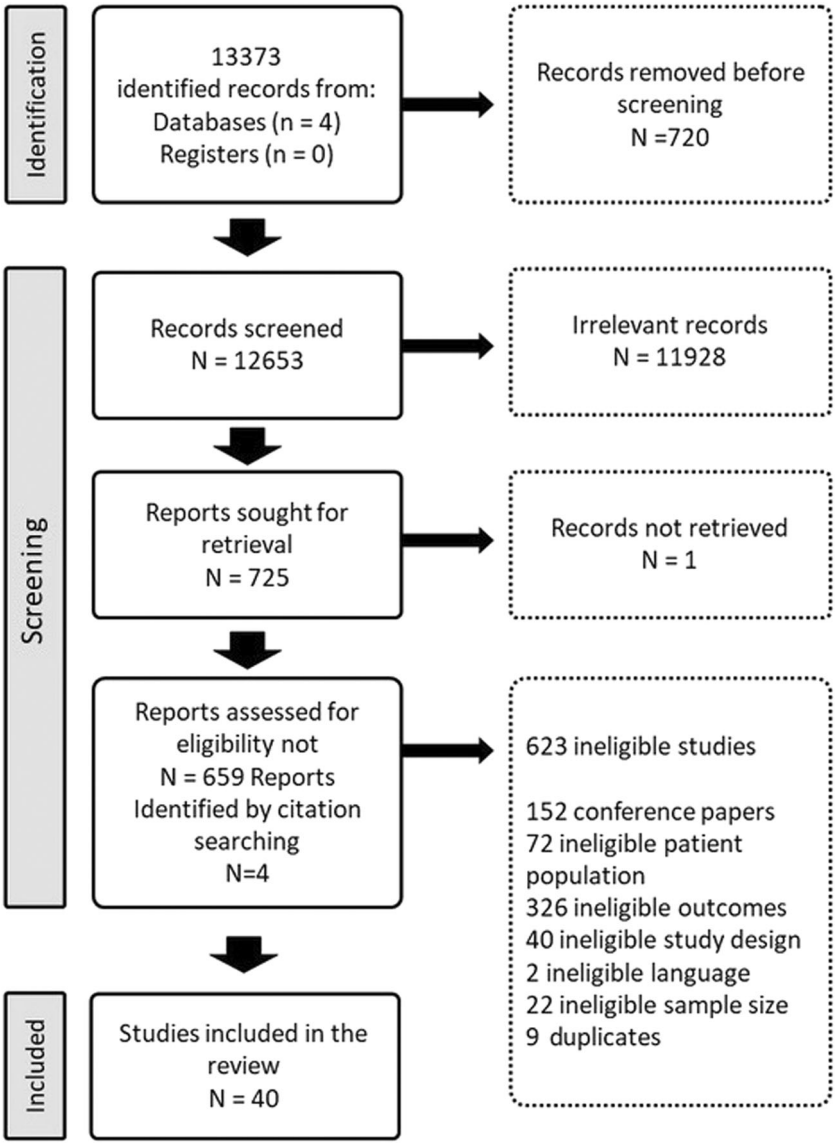

FIGURE 1 PRISMA chart

TABLE 1 Characteristics of the studies included in the meta-analysis

Author	Sample size	SMI	Setting	Country	WB region	WB income classification	Study design	Comparison with the general population	Comparison Males and Females	Overall risk of bias
Annamalai et al. (2017)	326	Schizophrenia	Outpatient	US	North America	HIC	Cohort	Yes	No	Medium
Bernstein et al. (2015)	62	Bipolar disorders	Outpatient	US	North America	HIC	Cross-sectional	No	No	High
Calkin et al. (2009)	276	Bipolar disorders	Inpatient	Canada	North America	HIC	Cross-sectional	No	No	Medium
Correll et al. (2008)	185	Any	Inpatient	US	North America	HIC	Cross-sectional	No	No	High
Davidson et al. (2001)	234	Any	Outpatient	Australia	East Asia & Pacific	HIC	Cross-sectional	Yes	Yes	High
de Caluwé et al. (2019)	350	Any	Out and Inpatient	Curaçao	Latin America & Caribbean	HIC	Cross-sectional	No	No	Low
Dickerson et al. (2006)	169	Any	Outpatient	US	North America	HIC	Cross-sectional	Yes	Yes	Low
Fagiolini et al. (2005)	171	Bipolar disorders	Outpatient	US	North America	HIC	Cross-sectional	No	No	Low
Feiler et al. (2012)	106	Any	Inpatient	Australia	East Asia & Pacific	HIC	Cross-sectional	Yes	Yes	Low
Fiedorowicz et al. (2008)	217	Bipolar disorders	Inpatient	US	North America	HIC	Cross-sectional	Yes	Yes	High
Galletly et al. (2012)	1286	Any	Community	Australia	East Asia & Pacific	HIC	Cross-sectional	No	Yes	Low
Huang et al. (2009)	650	Schizophrenia	Inpatient	Taiwan	East Asia & Pacific	LMIC	Cross-sectional	No	Yes	Low
Inamura et al. (2012)	15,171	Schizophrenia	Inpatient	Japan	East Asia & Pacific	HIC	Cross-sectional	No	Yes	Low
Kitabayashi et al. (2006)	273	Schizophrenia	Inpatient	Japan	East Asia & Pacific	HIC	Cross-sectional	Yes	Yes	Low
Lee et al. (2012)	100	Schizophrenia	Out and Inpatient	Singapore	East Asia & Pacific	HIC	Cross-sectional	Yes	No	Low
Leitão-Azevedo et al. (2006)	121	Schizophrenia	Outpatient	Brazil	Latin America & Caribbean	HIC	Cross-sectional	No	No	Low

(Continues)

TABLE 1 (Continued)

Author	Sample size	SMI	Setting	Country	WB region	WB income classification	Study design	Comparison with the general population	Comparison Males and Females	Overall risk of bias
Limosin et al. (2008)	5962	Schizophrenia	Out and Inpatient	France	Europe & Central Asia	HIC	Cross-sectional	No	Yes	Low
Łopuszańska et al. (2016)	91	Any	Inpatient	Poland	Europe & Central Asia	HIC	Cross-sectional	No	Yes	Low
Mackin et al. (2007)	106	Any	Outpatient	England	Europe & Central Asia	HIC	Cross-sectional	No	Yes	Low
Maina et al. (2008)	76	Bipolar disorders	Out and Inpatient	Italy	Europe & Central Asia	HIC	Cross-sectional	No	No	High
Marthoenis et al. (2014)	86	Schizophrenia	Inpatient	Indonesia	East Asia & Pacific	LMIC	Cross-sectional	No	No	Medium
McElroy et al. (2011)	875	Bipolar disorders	Community	UK	Europe & Central Asia	HIC	Cross-sectional	No	No	Low
McLaren et al. (2008)	5137	Any	Out and Inpatient	Canada	North America	HIC	Cross-sectional	No	No	Medium
Minsky et al. (2013)	586	Any	Out and Inpatient	US	North America	HIC	Cross-sectional	No	No	High
Nishiyama et al. (2007)	208	Schizophrenia	Inpatient	Japan	East Asia & Pacific	HIC	Cross-sectional	Yes	Yes	Medium
S.-C. Park et al. (2020)	420	Schizophrenia	Out and Inpatient	India	South Asia	LMIC	Cross-sectional	No	No	Low
S.-C. Park et al. (2020)	463	Schizophrenia	Out and Inpatient	Indonesia	East Asia & Pacific	LMIC	Cross-sectional	No	No	Low
S.-C. Park et al. (2020)	145	Schizophrenia	Out and Inpatient	Japan	East Asia & Pacific	HIC	Cross-sectional	No	No	Low
S.-C. Park et al. (2020)	230	Schizophrenia	Out and Inpatient	Malaysia	East Asia & Pacific	LMIC	Cross-sectional	No	No	Low
S.-C. Park et al. (2020)	184	Schizophrenia	Out and Inpatient	Taiwan	East Asia & Pacific	LMIC	Cross-sectional	No	No	Low

TABLE 1 (Continued)

Author	Sample size	SMI	Setting	Country	WB region	WB income classification	Study design	Comparison with the general population	Comparison Males and Females	Overall risk of bias
Post et al. (2014)	165	Bipolar disorders	Outpatient	Europe	Europe & Central Asia	HIC	Prospective Longitudinal	No	No	Medium
Post et al. (2014)	676	Bipolar disorders	Outpatient	US	North America	HIC	Prospective Longitudinal	No	No	Medium
Smith et al. (2020)	46	Any	Outpatient	UK	Europe & Central Asia	HIC	Cross-sectional	No	Yes	Low
Sugai et al. (2015)	19,678	Schizophrenia	Out and Inpatient	Japan	East Asia & Pacific	HIC	Cross-sectional	No	No	Low
Sušilová et al. (2017)	462	Schizophrenia	Inpatient	Czech Republic	Europe & Central Asia	HIC	Prospective Longitudinal	No	Yes	High
Tzeng et al. (2020)	260	Any	Inpatient	Taiwan	East Asia & Pacific	LMIC	Cross-sectional	No	No	Medium
Vedal et al. (2019)	750	Any	Outpatient	Norway	Europe & Central Asia	HIC	Cross-sectional	No	Yes	Low
Zavala et al. (2020)	1500	Any	Out and Inpatient	Bangladesh	South Asia	LMIC	Cross-sectional	No	No	Low
Zavala et al. (2020)	858	Any	Out and Inpatient	Pakistan	South Asia	LMIC	Cross-sectional	No	No	Low
Zhao et al. (2018)	466	Schizophrenia	Inpatient	China	East Asia & Pacific	LMIC	Cohort	Yes	No	Low

Abbreviations: HIC, high Income Country; LMIC, Low and middle-income country; SMI, severe mental illness; UK, United Kingdom; US, United States; WB, World Bank.

TABLE 2 Summary of the studies and the pooled prevalence of underweight according to World Bank classification, World Bank region, type of severe mental illness, setting, antipsychotic medication, and year of data collection

Variable	Number of studies	Percentage of studies (%)	Underweight (%) (95% CI)
Overall pooled prevalence	40	100	3.78 (2.85–4.99)
World Bank classification			
Higher income countries	30	75	3.40 (2.38–4.83)
Low and lower middle income countries	10	25	5.25 (3.73–7.34)
World Bank region			
East Asia and Pacific	16	40	4.96 (3.20–7.62)
North America	10	25	1.78 (1.24–2.55)
Europe and Central Asia	9	22.5	5.15 (3.24–8.11)
South Asia	3	7.5	7.50 (5.76–9.71)
Latin America and Caribbean	2	5	2.55 (1.45–4.43)
Year of data collection			
2000–2005	10	25	2.22 (1.16–4.21)
2006–2010	9	22.5	3.28 (2.02–5.26)
2011–2015	11	27.5	3.28 (1.75–6.04)
2016–2021	10	25	5.07 (3.46–7.39)
Type of SMI			
Any SMI[a]	15	37.5	3.33 (2.24–4.91)
Schizophrenia	17	42.5	5.35 (3.46–8.17)
Bipolar disorder	8	20	2.36 (1.61–3.45)
Setting			
Inpatient	13	32.5	4.26 (2.34–7.64)
Outpatient	11	27.5	2.59 (1.50-4.43)
Inpatient and outpatient	14	35	4.6 (3.23–6.49)
Community	2	5	2.37 (1.23–4.53)
Antipsychotic medication			
Prescribed[b]	36	90	3.70 (2.80–4.88)
Not prescribed	2	5	2.88 (0.98–8.17)
Not reported	2	5	7.09 (0.99–4.92)
SMI diagnostic tool			
DSM	21	52.5	-
ICD	9	22.5	-
DSM and ICD	2	5	-
Not specified	8	20	-
Study design			
Cross-sectional	35	87.5	-
Cohort	2	5	-
Prospective Longitudinal	3	7.5	-
Body mass index classification			
World Health Organization	36	90	-
Taiwan Standards	1	2.5	-
Japanese Society for the Study of Obesity	2	5	-
Indonesian Standards	1	2.5	-
Overall risk of bias			
Low	25	62.5	-
Medium	8	20	-
High	7	17.5	-

Abbreviations: DSM, Diagnostic and Statistical Manual for Mental Disorders; ICD, International Classification of Diseases; SMI, severe mental illness.

[a]The "any" category includes studies where the estimates of underweight were not separated between the type SMI, we did not find studies looking at major depression with psychotic features independently and only found one study looking at first episode of psychosis which was included in the "schizophrenia" category.

[b]Studies including participants with prescribed antipsychotic medication or open population (mix of participants taking and not taking antipsychotic medication).

and the lowest prevalence in Australia (1.7%) and the United States (1.5%).

From the included studies, nine compared the prevalence of underweight in people with SMI ($n = 2066$) and the general population ($n = 42055$). The pooled odds of people with SMI of being underweight were 0.65 (95% CI = 0.44–0.95. $p = 0.02$) lower as compared with the general population ($I^2 = 55\%$, $t^2 = 0.16$). Figure 4 shows the odds of people with SMI being underweight compared with the general population, according to type of SMI, World Bank country classification, World Bank region, and year of data collection. The odds of people with SMI of being underweight compared to the general population were lower in HIC than in LMICs. North America was the region with the highest odds ratio followed by East Asia and the Pacific. However, in all regions, the odds of underweight were lower in SMI than in the general population.

There were differences according to the specific SMI, people with bipolar disorder had higher odds of having underweight compared with the general population, while people with schizophrenia had lower odds

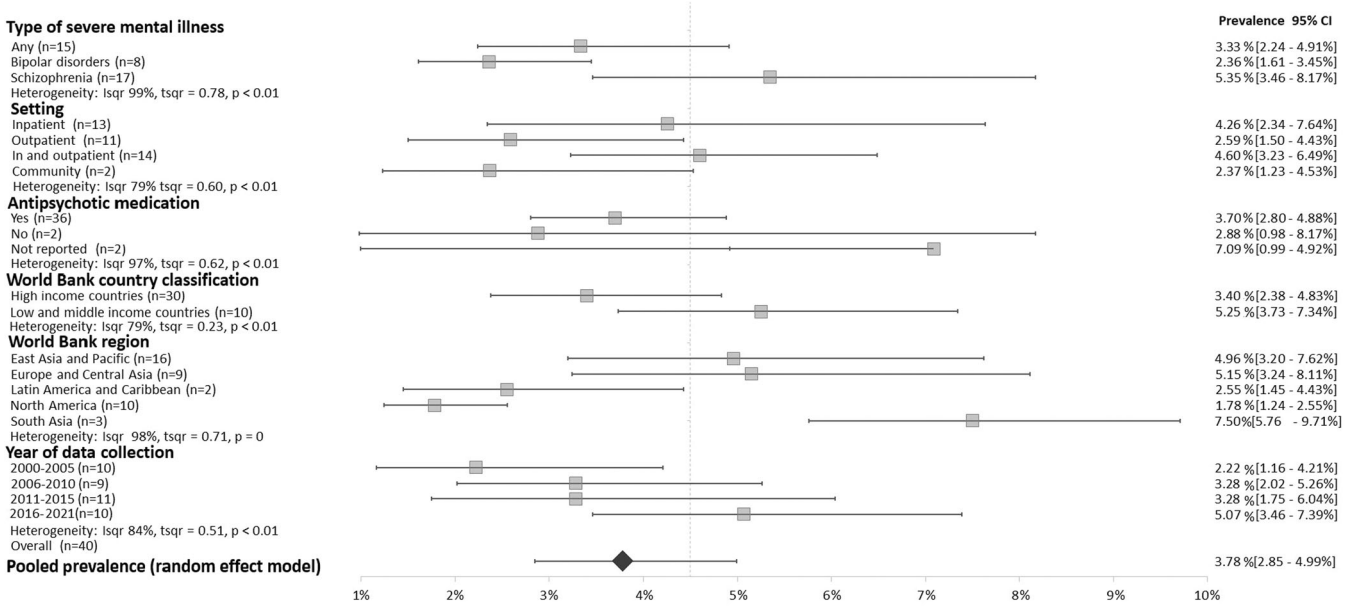

FIGURE 2 Forest plot representing the pooled prevalence of underweight in people with severe mental illness according to severe mental illness, geographical region, World Bank classification, antipsychotic medication use, and year of data collection.

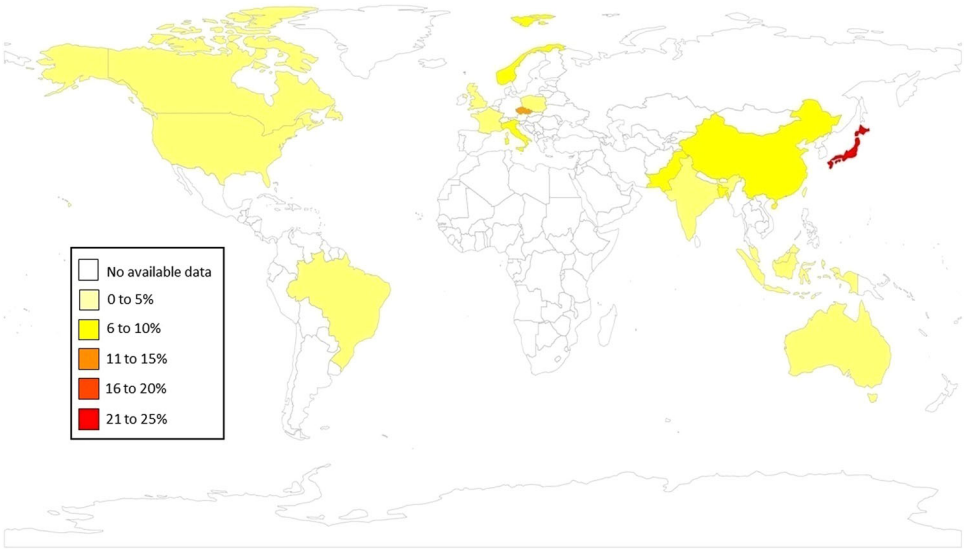

FIGURE 3 Geographical variation in the prevalence of underweight in people with severe mental illness

of having underweight. We found five studies where the prevalence of underweight was provided for females and males, females with SMI had higher odds of having underweight as compared to men with SMI ($n = 37405$, $I^2 = 83\%$, $t^2 = 6.67$).

4 | DISCUSSION

This is the first systematic review to investigate the prevalence of underweight in people with SMI according to the type of SMI, setting, and region of the world. We found a relatively higher prevalence of underweight in Japan and the region of South Asia, Europe, and Central Asia and a lower prevalence in the region of North America. The pooled prevalence of underweight was higher in people with bipolar disorder than in schizophrenia, and women with SMI had higher odds of being underweight than men with SMI.

The pooled prevalence of underweight in people with schizophrenia found in the current meta-analysis is lower (5.4%) than the pooled prevalence found by Sugawara et al. (2018) which reported a pooled prevalence of 6.2%. This marginal difference in people with schizophrenia might be due to the proportion of studies from Japan (the country with the highest prevalence of underweight) included in both reviews (24% vs. 5%). The higher prevalence of underweight found in people with schizophrenia (compared with people with bipolar disorder) might

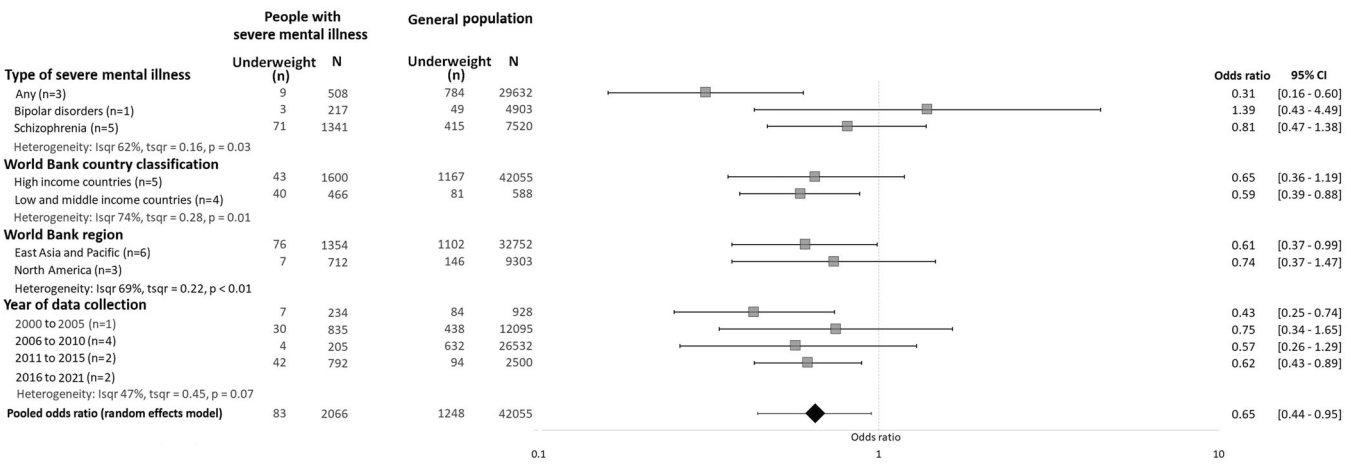

FIGURE 4 Odds of people with severe mental illness of being underweight compared with the general population

be due to social withdrawal, isolation, self-neglect, and the higher prevalence of negative symptoms seen in this population (Ng et al., 2021). Lack of motivation and negative symptoms can contribute to insufficient dietary intake and therefore undernutrition (Sugai et al., 2015). It should be acknowledged that the lower odds of having underweight found in people with bipolar disorder (as compared with the general population) was based on the single estimate from one study investigating people with bipolar disorder, which reduces the reliability and representativeness of this figure. Women with SMI were more likely to be underweight, which is in line with global trends seen in the general population (Global Nutrition Report, 2020) showing a higher prevalence of underweight in women than men.

The lower odds of people with SMI of having underweight compared with the general population were expected considering the high rates of obesity reported in this population due to the metabolic side effects of antipsychotic medication, the prevalence of health risk behaviors, and socioeconomic disadvantages related to higher unemployment rates (Adams, 2020; Holt & Peveler, 2009). Antipsychotic medication adversely impacts metabolism through direct and indirect effects on lipids and insulin sensitivity, therefore contributing to the increasing rates of weight gain and metabolic syndrome seen in this population (Libowitz & Nurmi, 2021). In line with this finding, a recent meta-analysis (Afzal et al., 2021) including 24 studies found that people with SMI are 3.04 times more likely of being obese than people in the general population. Despite the low prevalence of underweight and the lower odds of people with SMI of having underweight, other forms of malnutrition should not be discounted. A few studies (Grønli et al., 2013; Nunes et al., 2014) have demonstrated that people with SMI have a poor diet with excess of calories, sugar, and saturated fat with low nutritional quality and are more likely to have a micronutrient deficiency than the general population. More research is required to investigate the double burden of malnutrition (i.e., obesity and micronutrient deficiencies) in this population, to better understand undernutrition in this population and help inform future health strategies.

The higher prevalence of underweight in inpatients (compared with outpatients) was also reported by Sugai et al. (2015) where Japanese inpatients were more likely to be underweight than their counterparts in the community. Long-term hospitalization often leads to reduced physical activity, therefore, lowering bone density, which has been reported to be related to underweight (Carter & Hinton, 2014; Pines, 2012). Another reason may be because inpatients are more likely to have a refractory degree of mental illness that can manifest with cognitive impairment and psychotic symptoms, leading to an element of diagnostic overshadowing, where health professionals may mistakenly attribute symptoms of a physical illness to their underlying psychiatric illness (Molloy et al., 2020). This may lead to clinicians overlooking or undertreating physical health problems that could be contributing to being underweight (Sugai et al., 2015). It is therefore important that signs of undernutrition are acknowledged and adequately assessed in this at-risk population.

The pooled prevalence of underweight of people with SMI living in LMICs was higher than those living in HICs. Being underweight is associated with increased susceptibility to infection and reduced work capacity leading to lower income and increased mortality (Fekadu et al., 2015; Flegal et al., 2005). The differences between HICs and LMICs might be explained by the same sociodemographic factors seen in the general population such as higher unemployment rates, and limited access to social programs as well as other factors specific to the SMI population such as depression and negative symptoms which are associated with higher unemployment rates and lower food intake.

5 | STRENGTHS AND LIMITATIONS

Due to the variety of geographical regions, intake of antipsychotic drugs and types of SMI, there was considerable heterogeneity between the studies which cannot be mitigated by sample stratification. We did not adjust for unmeasured variables such as dietary intake of the population. Also, there were limited studies conducted in LMICs compared to HICs, which reduces the confidence in the LMIC

estimate. Two studies were also excluded due to not being in English. Another potential limitation is that most of the included studies are cross-sectional, so it is difficult to establish the temporal relationship between underweight and SMI. Despite these limitations, this is the first study conducted to examine the prevalence of underweight in people with SMI from a global perspective, estimating the prevalence and trend of underweight from every region of the world and according to the type of SMI and setting.

6 | CONCLUSION

We found that people with any SMI are less likely to be underweight compared to the general population. People with schizophrenia had the highest prevalence of underweight compared to other types of SMI, this was still lower than the general population. The pooled prevalence of underweight in Japan and South Asia was significantly higher than any other world region.

There is scope for further research into the prevalence of underweight in people with SMI in LMIC, which is underrepresented in the current data and may provide contextual information to produce targeted interventions.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

OPEN RESEARCH BADGES

This article has earned Open Data, Open Materials and Preregistered Research Design badges. Data, materials and the preregistered design and analysis plan are available at https://pure.york.ac.uk/portal/files/74735049/Underweight_and_obesity_people_wit_SMI_Dataset_11_11_21.xlsx.

DATA AVAILABILITY STATEMENT

The data are publicly available at: https://pure.york.ac.uk/portal/files/74735049/Underweight_and_obesity_people_wit_SMI_Dataset. [Correction added on 17 December 2022, after first online publication: Peer review history is not available for this article, so the peer review history statement has been removed.]

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