Burden of excessive gestational weight gain and postpartum weight retention among Indian women - A systematic review and meta-analysis

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ABSTRACT

Background: Excessive weight gain during pregnancy and weight retention in the postpartum period may lead to obesity, diabetes mellitus, and cardiovascular events among women in later life, as well as adverse perinatal outcomes, and long-term offspring health outcomes during the current and subsequent pregnancies. However, most studies of gestational weight gain (GWG) and postpartum weight retention (PPWR) are in western and developed countries. Therefore, this paper aimed to determine the burden of gestational weight gain and postpartum weight retention among Indian women.

Materials & methods: Three electronic database- Medline, Google Scholar, and Cochrane library were searched for studies up until March 31, 2022. Studies on GWG and PPWR from India were included in the review. Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) checklist was used for reporting the current review. Online platform Rayyan was used to screen and select the studies. Data were extracted from the 13 selected articles and pooled estimates, proportion and mean of GWG & PPWR along with 95% CI were estimated.

Results: Overall 271 articles were identified after the initial search and 13 articles were included (n = 6656) in the review. Nine studies reported proportion of women with excessive GWG, seven studies reported mean GWG and three studies described weight retention among postpartum mothers. The pooled proportion of Indian pregnant women with excessive GWG was found to be 16.48% (95% CI: 11.52, 21.43) and the pooled mean of GWG was 10.08 kg (95% CI: 7.81 – 12.34). The highest pooled proportion of women with excessive GWG was reported in the North region with 22.57% and the lowest in the East region with 9.15%. The highest pooled mean of GWG was reported in the East region with 12.90 kg and the lowest in the North region with 6.40 kg. Findings from three studies were systematically reviewed and summarized for postpartum weight retention among Indian women.

Conclusion: Although majority of Indian women achieved GWG less than the recommendations, there is a need for larger population based surveys among Indian women to obtain adequate, appropriate and complete health related information about weight changes during and after pregnancy.

1. Introduction

Nutritional status of a pregnant woman is crucial for both the mother and the developing fetus. The baby in the womb depends on the mother for all the nutrition and the “First 1000 Days” from the day of conception till the child is 2 years of age, is a vital period for the physical and mental growth of a child. Adequate gestational weight is one of the criteria to measure maternal nutrition status. Appropriate gestational weight gain (GWG) is essential for fetal growth and positive maternal and childbirth outcomes. Inadequate GWG is associated with low birth weight, small for gestational age, preterm birth, birth asphyxia, neonatal intensive care unit admission, etc. Excessive gestational weight gain (E-GWG) results in a high incidence of non-communicable diseases (NCDs) like obesity, diabetes mellitus, and cardiovascular events among women in later life, as well as adverse perinatal outcomes such as preterm delivery, cesarean delivery, complicated deliveries, gestational diabetes mellitus, preeclampsia, altered fetal growth, infant mortality, and long-term offspring health outcomes during the current and subsequent pregnancies.

With the rising trends in obesity, it is estimated by 2025, 2.7 billion
adults will be overweight and over one billion will be affected by obesity. Globally the prevalence of obesity among adult women (aged >20 years) increased from 6% to 15% from 1975 to 2016. Overweight and obesity among women in India were found to be higher among women aged 18–69 years (21.0% overweight and 8.3% obese) than men (19.0% overweight and 4.3% obese). While much of obesity in the 18–69 years age group could be attributed to menopausal related factors, obesity among women in the reproductive age group, i.e. 18–49 years, was 6.4%, which was higher than 4.0% among men. It was found that the prevalence of overweight and obesity among women in the reproductive age group was relatively higher among those who are older, living in an urban area, and belonged to the highest wealth quintile. Other important factors that are attributed to overweight and obesity among this group are E-GWG and postpartum weight retention (PPWR).

The Institute of Medicine (IOM) guidelines recommend a specific range of weight gain during pregnancy based on pre-pregnancy weight status: 11–16 kg for normal pre-pregnancy BMI (18.5–24.9 kg/m²), 7–11.5 kg for BMI 25–29.9 kg/m² and 5–9 kg for obese women (>30 kg/m²). Evidence from studies shows that GWG exceeding the IOM guidelines is associated with complications during pregnancy and delivery, adverse postnatal and child-related outcomes, excessive PPWR, perpetuating intergenerational cycles of obesity, and associated comorbidities such as hypertension and diabetes. GWG is the first step in the vicious cycle and is often highly variable between women while weight retained post-pregnancy depends on pre-pregnancy BMI and amount of GWG. An extensive meta-analysis of 69,000 pregnant women reported that weight gained excessively during pregnancy retains even 20 years later. PPWR during childbearing years is one of the avoidable predisposing factors for long-term obesity among women. It is a preventable risk factor for all types of NCDs because behavioral interventions can easily be targeted during post-delivery maternal care.

Studies conducted worldwide report normal weight and overweight women with GWG above the IOM guidelines have a three times higher risk of retaining more than five kilograms postpartum as compared to those with GWG within the recommendations. A study conducted among Indian women reports that 22% of the pregnant women gained weight more than the recommended weight and 37% gained less than the recommendation. Recent literature on PPWR from India reported that 90% of the women retained weight near to one-year post-delivery.

Given the rise in the burden of overweight and obesity among WRA in India and the lack of guidelines and the prevention, control, and monitoring of E-GWG and PPWR, there is a need to know its burden in the population. Although there are recommendations to tackle gestational diabetes mellitus (GDM) and other NCDs during pregnancy, there are no standard guidelines for preventing, screening, and treating overweight and obesity during pregnancy in India. Considering the rise of the double burden of malnutrition and associated NCDs in India, especially among women in the reproductive age group, it becomes crucial to identify the community burden, preventable risk factors, health policies, and targeted behavioral interventions focussing on women at risk during pregnancy with E-GWG and PPWR. To the best of our knowledge, there is no systematic review and meta-analysis published among Indian women regarding pooled burden of E-GWG and PPWR. Therefore, in this systematic review and meta-analysis, we tried to address the existing literature gaps to estimate the proportion of Indian women with excessive gestational weight gain at ≥ 36 weeks of gestation and weight retention at 6th and 12th months postpartum and mean weight gain and weight retention.

2. Methods

This systematic review and meta-analysis was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This protocol was registered with the PROSPERO International Prospective Register of Systematic reviews (registration number CRD42022315706).

2.1. Search strategy and eligibility criteria

We searched three database MEDLINE (via PubMed), Google Scholar, and Cochrane library without any restrictions on language, date, or article type up until March 31, 2022, for studies estimating the proportion of women with excessive gestational weight gain and postpartum weight retention in India. A combination of medical subject heading (MeSH) and free-text terms such as “gestational weight gain”, “Postpartum weight retention”, “India”, “Pre-pregnancy BMI”, etc. was used for carrying out the literature search. Articles were identified using the following search terms: ((Proportion OR Prevalence OR Frequency OR Epidemiology OR "Epidemiologic studies" OR Distribution OR Status) AND ("Gestational weight" OR "Weight gain" OR "Pregnancy weight gain" OR "Maternal weight gain" OR "Weight retention" OR "Postpartum weight retention" OR "Maternal obesity")) AND (Women OR Pregnan*) AND (India).

Identified studies were imported into Rayyan Software after removing the duplicates. Two authors (NP and VL) independently screened the titles and abstracts of the studies. Any disagreements were resolved through consensus or consultation with a third author (SL). Full-text articles were retrieved for the shortlisted abstracts, and inclusion and exclusion criteria were used to thoroughly assess the eligibility of the full-text articles for review. Reasons for exclusion were recorded for articles that were not eligible for the review. The eligibility criteria were defined as follows: (i) Observational studies and clinical trials conducted among pregnant women with singleton pregnancy; (ii) Studies conducted in India; (iii) Studies that have estimated GWG at ≥ 36 weeks of gestation and PPWR at 6th and 12th month postpartum; (iv) Sufficient data is available in the article to extract the numerator and denominator for relevant measures, the proportion of excessive GWG and PPWR and mean estimates; (v) Studies available in English language and full-text article. We excluded studies on twin pregnancy, among adolescents, reviews, meta-analyses, abstracts, conference proceedings, and letters/editorials/commends. In addition, reference lists of the retrieved articles were also searched for additional publications.

2.2. Data extraction and quality assessment

Two authors (NP and VL) extracted the data from the included articles selected for the final review in the pre-designed data extraction form in Microsoft Office Excel 2010. The following information was extracted from the selected articles: name of the first author, publication year, study design, sampling strategy, study setting, study area, sample size, mean age or age range of participants, IOM criteria for gestational weight gain, proportion of women with E-GWG and weight retention and mean estimates. The quality of observational studies (cohort/case-control) was assessed by using Newcastle-Ottawa Scale (NOS) under three main domains: the basis of selection, comparability, and outcome criteria. A NOS score of 7 and above was considered to be with a low risk of bias while score of 3 and below with a high risk of bias.

2.3. Outcomes

Proportion of women with E-GWG at ≥ 36 weeks of gestation based on IOM, 2009 guidelines and weight retention at 6th and 12th months postpartum were considered as primary outcome measures. Additionally, mean GWG ≥36 weeks of gestation, and weight retention at 6th and 12th months postpartum were estimated.

2.4. Statistical analysis

Characteristics of individual study and risk of bias were tabulated. Meta-analysis of the selected articles was performed using the STATA software (version 17). Standard error (SE) for the proportion was
calculated from the reported proportion of the outcome and sample size, for each study. Standard error (SE) for the mean was calculated from the standard deviation (SD) of the outcome and sample size, for each study. Misra A et al. did not report SD for mean GWG, so it was imputed with the average of SD reported by other studies. Banerjee N et al. reported mean and SD of GWG for two subgroups (urban and rural), so we calculated a pooled SD. Pooled estimate along with 95% Confidence Intervals, which is the proportion of E-GWG & PPWR, and mean GWG & PPWR were estimated through random effects model and restricted maximum likelihood estimation method. Cochrane’s Q statistical test of heterogeneity and I² statistic (percentage of residual variation attributed to heterogeneity) was performed to evaluate heterogeneity. Publication bias was assessed by visual inspection of funnel plots and small-study effect was assessed by Egger’s test. Studies included in our review varies over a long span of time (1995–2021). To account for time-effect of the studies on the outcome we performed subgroup analysis based on criteria used for recording E-GWG. The IOM, 2009 guidelines are used to categorize GWG in the majority of the included studies. Only four articles published before 2009 did not employ standardized criteria. To evaluate GWG, globally IOM recommendations are used, and no additional criteria have been developed since then. Subgroup analysis was performed to explore heterogeneity based on the region of the study, urban/rural setting and criteria for gestational weight, for both the outcome measures.

3. Results

3.1. Study selection

Overall 271 articles from three databases were identified after the initial search. After excluding duplicates and animal studies, titles and abstracts were screened for 174 articles, and 49 potentially eligible articles were retrieved in full text. After reviewing the full text, 36 articles were excluded because of different study designs, populations, and/or study outcomes. Finally, 13 articles met the inclusion criteria and were included in this systematic review and meta-analysis (Fig. 1). Among the 13 included studies, nine studies reported proportion of women with E-GWG, seven studies reported mean GWG and three studies described weight retention among postpartum mothers.

Fig. 1. PRISMA flowchart of study selection process.
3.2. Study characteristics

Table 1 shows the detailed characteristics of the selected studies. Among the included studies three were published between 1995 and 2010 (13,17,21–25), and eight studies were published between 2011 and 2021 (13,17,21–25). Four studies were from the South region (13,17,21,22,25) three studies were from the North region (13,17,22,25) two were from the East (13,18) and one was from the West (13,17,22,25) region of India. The total number of participants for this review was 6656 and the sample size ranged from 22 to 2728.

Of the total included studies, six were prospective longitudinal studies, (13,17,21,22,25) three were cross-sectional (13,17,22,25) and one each was retrospective (26) and randomized controlled trial (22). Seven studies followed IOM, 2009 guidelines for reporting excessive gestational weight gain. (13,17,21,22,25) Among the 14 studies included in the review, mean gestational weight gain with standard deviation was reported by seven studies (13,17,19,21,22,24,25) and proportion of E-GWG was reported by nine studies (13,17,20–26).

3.3. Quality assessment

Seven studies had a moderate risk of bias, scores ranging from 4 to 6 stars, (13,17,21,22–26) while one study had a low risk of bias with a score of 7 stars (22). Rest three studies scored less than 3 stars and showed a high risk of bias on the Newcastle-Ottawa Scale. (13,17,22,25) Under the selection bias domain, seven studies had high bias risk related to sample size justification (13,17,21,22,25) and eight studies had high bias risk related to non-response (13,17–20,24–26). Under the comparability domain, all the studies showed high bias risk related to control of biases, however, none of the studies showed a high risk of bias under the outcome domain.

3.4. Synthesis of results

3.4.1. The proportion of Indian pregnant women with excessive gestational weight gain

Nine studies reported proportion of pregnant women with E-GWG. (13,17,20–26) Findings from our review showed the pooled proportion of Indian pregnant women with E-GWG to be 16.48% (95% CI: 11.52, 21.43) (Fig. 2). There was significant heterogeneity between the studies with an I2 of 96.08% and a p-value < 0.001. Data by regions showed the highest pooled proportion of women with E-GWG in the North region with 22.57% (95% CI: 0.54, 44.61) and the lowest in the East region with 9.15% (95% CI: 5.53, 12.77) (Fig. 51). Studies conducted in the Eastern region had lower heterogeneity with I2 of 52.98% and a p-value of 0.14. There was a significant difference in the proportion of pregnant women with E-GGW in the studies conducted among the various regions in India (p-value < 0.001). Studies following IOM, 2009 guidelines for GWG reported pooled proportion of women with E-GWG to be 15.55% (95% CI: 10.52, 20.57), and studies without any standardized criteria reported pooled proportion of women with E-GWG to be 18.25% (95% CI: 7.22, 29.28) (Fig. S2). There was a significant difference in the proportion of pregnant women with E-GWG in the studies conducted based on the baseline used for GWG in India (p-value < 0.001). Urban setting showed higher pooled proportion of women with E-GWG [17.41% (95% CI: 11.51, 23.30)] as compared to rural setting [13.51% (95% CI: 2.04, 24.97)] (Fig. S5).

We checked publication bias graphically by funnel plot and it showed signs of asymmetry (Fig. S7). The Egger test for asymmetry reflected no publication bias statistically (p = 0.12).

3.4.2. Mean gestational weight gain among Indian pregnant women

Seven studies reported mean GWG among pregnant women (13,17,19,21,23). The pooled mean of GWG among Indian pregnant women was 10.08 kg (95% CI: 7.81–12.34). There was significant heterogeneity between the studies with an I2 of 99.77% and a p-value < 0.001. (Fig. 3) Data by regions showed the highest pooled mean of GWG in the East region with 12.90 kg (95% CI: 12.68–13.12) and the lowest in the North region with 6.40 kg (95% CI: 2.70–10.11) (Fig. S4). Studies conducted in the South region had lower heterogeneity with I2 of 21.5% and a p-value of 0.26. There was a significant difference in the mean GWG in the studies conducted among the various regions in India (p-value < 0.001). Studies following IOM, 2009 guidelines for GWG reported a pooled mean of GWG to be 11.70 kg (95% CI: 9.35–14.05), and studies without any standardized criteria reported a pooled mean of

Table 1

<table>
<thead>
<tr>
<th>Reference</th>
<th>First Author</th>
<th>Year</th>
<th>Sample size</th>
<th>Study design</th>
<th>Region</th>
<th>Setting</th>
<th>Urban/rural</th>
<th>Criteria for GWG</th>
<th>Proportion of E-GWG (%)</th>
<th>Mean (SD) GWG</th>
<th>NOS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Mishra KG et al.</td>
<td>2017–2019</td>
<td>418</td>
<td>Prospective cohort</td>
<td>East</td>
<td>Community-based</td>
<td>Rural</td>
<td>IOM</td>
<td>7.7</td>
<td>12.9 (2.99)</td>
<td>6</td>
</tr>
<tr>
<td>22</td>
<td>Bauserman MS et al.</td>
<td>2013</td>
<td>590</td>
<td>Randomized controlled trial</td>
<td>South</td>
<td>Community-based</td>
<td>Rural</td>
<td>IOM</td>
<td>19.4</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>23</td>
<td>Raji L et al.</td>
<td>2012</td>
<td>180</td>
<td>Longitudinal study</td>
<td>West</td>
<td>IOM</td>
<td>Rural</td>
<td>IOM</td>
<td>20.78</td>
<td>13.4 (3.44)</td>
<td>5</td>
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<tr>
<td>24</td>
<td>Bhavadharini B et al.</td>
<td>2011–2014</td>
<td>2728</td>
<td>Retrospective study</td>
<td>South</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>IOM</td>
<td>17.3</td>
<td>–</td>
<td>6</td>
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<tr>
<td>25</td>
<td>Rajput R et al.</td>
<td>2009–2011</td>
<td>607</td>
<td>Cross-sectional</td>
<td>North</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>NM</td>
<td>11.7</td>
<td>4.52 (1.6)</td>
<td>5</td>
</tr>
<tr>
<td>26</td>
<td>Pal R et al.</td>
<td>2010</td>
<td>200</td>
<td>Prospective cohort</td>
<td>East</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>IOM</td>
<td>11.5</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>27</td>
<td>Banerjee N et al.</td>
<td>1998</td>
<td>206</td>
<td>Cross-sectional</td>
<td>North</td>
<td>Hospital-based</td>
<td>Urban and rural</td>
<td>NM</td>
<td>–</td>
<td>8.3 (3.11)</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>Piers LS et al.</td>
<td>1994</td>
<td>22</td>
<td>Prospective cohort</td>
<td>South</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>Hospital-based</td>
<td>–</td>
<td>11.4 (3.7)</td>
<td>3</td>
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<tr>
<td>20</td>
<td>Dahiy S</td>
<td>2002²</td>
<td>120</td>
<td>Prospective longitudinal study</td>
<td>North</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>NM</td>
<td>34.2</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>Radhakrishnan U et al.</td>
<td>2014</td>
<td>1462</td>
<td>Cross-sectional</td>
<td>South</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>IOM</td>
<td>21.4</td>
<td>10.5 (4.46)</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>Misra A</td>
<td>2015³</td>
<td>123</td>
<td>Longitudinal study</td>
<td>West</td>
<td>Hospital-based</td>
<td>Urban</td>
<td>IOM</td>
<td>8.1</td>
<td>9.61 (3.04)</td>
<td>3</td>
</tr>
</tbody>
</table>

*NM - Not mentioned.
²IOM – Institute of Medicine,2009 guidelines for gestational weight gain.
³Publication year.
⁴NOS – Newcastle–Ottawa Scale.15
GWG to be 9.42 kg (95% CI: 6.46–12.38) (Fig. S5). There was a significant difference in the mean GWG in the studies conducted based on the guideline used for GWG in India (p-value < 0.001). Rural setting showed higher pooled mean of GWG as 12.90 kg (95% CI: 12.68, 13.12) (Fig. S6). There was a significant difference in the mean GWG in the studies conducted based on urban/rural setting (p-value < 0.001).

The funnel plot showed signs of asymmetry (Fig. S8) but the Egger test for asymmetry depicted no publication bias statistically (p = 0.48). This inconsistency between the results of the plot and test could be attributed to the fewer number of studies.

3.4.3. Postpartum weight retention among Indian women

Only three studies\(^19,27,28\) described weight retention among postpartum mothers concerning the Indian context and we did not find

![Figure 2](image2.png)

**Fig. 2.** Forest plot depicting the pooled proportion of Indian pregnant women with excessive gestational weight gain (n = 9).

![Figure 3](image3.png)

**Fig. 3.** Forest plot depicting the pooled mean of gestational weight gain among Indian pregnant women (n = 7).

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean gestational weight gain with 95% CI (%)</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajput et al.</td>
<td>4.52 [4.39, 4.65]</td>
<td>564</td>
</tr>
<tr>
<td>Neelum Banerjee et al.</td>
<td>8.30 [7.88, 8.72]</td>
<td>206</td>
</tr>
<tr>
<td>Lt Akshay Misra et al.</td>
<td>9.61 [9.07, 10.15]</td>
<td>123</td>
</tr>
<tr>
<td>U. Radhakrishnan et al.</td>
<td>10.50 [10.27, 10.73]</td>
<td>1462</td>
</tr>
<tr>
<td>Piers et al.</td>
<td>11.40 [9.85, 12.95]</td>
<td>22</td>
</tr>
<tr>
<td>Rajee et al.</td>
<td>13.40 [12.90, 13.90]</td>
<td>180</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>10.08 [7.81, 12.34]</td>
<td></td>
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</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>Reference</th>
<th>First Author</th>
<th>Year</th>
<th>Sample size</th>
<th>Study design</th>
<th>Region</th>
<th>Setting</th>
<th>Postpartum weight retention (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^27)</td>
<td>Kajale A et al.</td>
<td>2015</td>
<td>300</td>
<td>Cross-sectional study</td>
<td>West</td>
<td>Hospital-based</td>
<td>Urban Postpartum weight retention (kg)</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Group A: 7-day of delivery: 9.0 (5.8)</td>
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<td></td>
<td>Group B: 1-2 years: 3.0 (7.0)</td>
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<td></td>
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<td></td>
<td>Group C: 3-4 years: 6.5 (10)</td>
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<td></td>
<td>Postpartum weight loss (kg)</td>
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<td>6th month: –1.1 (–9.7, 10.5)</td>
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<td></td>
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<td>12th month: –2.4 (–12.4, 8.2)</td>
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<td></td>
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<td>18th month: –2.2 (–10.3, 9.1)</td>
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<td>24th month: –1.9 (–12.4, 10.2)</td>
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<td>Postpartum weight loss (kg)</td>
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<td>12th week: 0.36 ± 1.69</td>
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<td></td>
<td></td>
<td></td>
<td>24th week: 0.29 ± 2.0</td>
</tr>
<tr>
<td>(^28)</td>
<td>Onyango W et al.</td>
<td>1997</td>
<td>267</td>
<td>Longitudinal study</td>
<td>All regions</td>
<td>Community-based</td>
<td>Urban Postpartum weight loss (kg)</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>12th week: 0.36 ± 1.69</td>
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<td></td>
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<td></td>
<td></td>
<td>24th week: 0.29 ± 2.0</td>
</tr>
<tr>
<td>(^19)</td>
<td>Piers LS et al.</td>
<td>1994</td>
<td>17</td>
<td>Prospective cohort study</td>
<td>South</td>
<td>Hospital-based</td>
<td>Urban Postpartum weight loss (kg)</td>
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<td>12th week: 0.36 ± 1.69</td>
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sufficient studies to conduct the meta-analysis, so findings from three included articles were systematically reviewed and summarized (Table 2).

4. Discussion

In this review of 6656 pregnancies, we present a systematic review and meta-analysis incorporating women from different regions of India and from across the BMI range. Our findings show that the proportion of women with E-GWG above the recommendation are 16.48%. A review conducted globally reported proportion of women with E-GWG above the IOM 2009 guidelines as 39.4%. Data by regions showed 20.2% of women had E-GWG above the IOM 2009 guidelines among the Asian population.

A lesser percentage of women in India reported E-GWG as compared to Asian and global findings. Interestingly, the proportion of women with E-GWG in the Indian population was also significantly lower as compared to diverse international cohorts. Factors influencing excessive weight gain during pregnancy can be multifaceted. They can be related to higher pre-pregnancy BMI, an unhealthy diet, insufficient physical activity, psychological factors, social inequality, and cultural barriers.

While the impact of the rising obesity epidemic among women of reproductive age group in developed countries has been highlighted, recent data from NFHS-5 demonstrate that the prevalence of obesity in women has increased significantly across all states of India. The proportion of overweight women in India increased from 20.6% to 24% in last five years. A secondary analysis of NFHS-4 reported national prevalence of overweight obesity among pregnant women as 12% and postpartum women as 13%

Another leading factor for obesity among women of reproductive age group is polycystic ovary syndrome (PCOS). In Indian population the prevalence of PCOS ranges from 3.7%–22.5%. The metabolic and hormonal imbalance during PCOS can lead to weight gain and eventually obesity among women. Obesity further can exacerbate the symptoms of PCOS resulting into reproductive abnormalities. Higher pre-pregnancy BMI will contribute to excessive weight gain during pregnancy and long term postpartum weight retention which in turn is an independent risk factor for cardiometabolic complications in later stages of life.

The difference in GWG across countries could be attributed to the difference in socio-economic, cultural, and epidemiological conditions. In recent decades a nutritional transition has been observed and consumption of processed and ultra-processed food has increased. The prevalence of overweight and obesity among women of reproductive age is much higher in developed countries than in developing countries.

Transitions from normal weight to overweight and obesity in midlife have been found to be significantly associated with increased likelihood of major chronic diseases such as coronary heart disease, diabetes, cancer, metabolic syndrome and increased risk of mortality overall due to cardiovascular diseases.

Various forms of cultural beliefs, misconception about weight gain during pregnancy and food taboos are still widespread and exists towards certain foods in various countries. It refers to the restriction of specific foods as a result of social or religious customs. Food taboos were found to be prevalent among remote rural communities with little access to nutrition and health services, older, and uneducated women. There are several myths associated with the postpartum period as well. Especially in Asian countries like India, the period of confinement for the first forty days post-delivery is usually practiced. Consequently, postpartum women land up being sedentary. Eventually, cultural beliefs, whether right or wrong, tend to shape behaviours and habits, hence putting the woman at a greater risk of adverse pregnancy outcomes.

Moreover, among different states of India, we observed a significant difference in the proportion of women with excessive GWG. The North region had the highest proportion of women with excessive GWG whereas East region had the lowest. The individual socioeconomic status, different ethnicity and socio-cultural variations across regions of India are independent risk factors influencing BMI status among women. The wealthier population of the country is prone to develop obesity because of the high consumption of processed and ultra-processed food and sedentary lifestyle. Also populations belonging to lower socioeconomic status with access to fewer resources, low health literacy, poor awareness, and compromised diet quality are equally at high risk to become overweight and obese. And since higher pre-conception BMI is already a proven significant risk factor for E-GWG, PPWR and pre-gravid obesity in future pregnancies, there is a need for weight management strategies during and after pregnancy.

The guidelines by the IOM 2009 recommend a GWG of 11.5–16 kg for a woman with a BMI ranging from 18.5-24.9 kg/m². Our findings show that a mean GWG among Indian pregnant women was 10.08 kg. A review conducted globally reported pooled mean of GWG as 13.4 kg and data by regions showed a pooled mean of GWG to be 11.4 kg among the Asian population. There was a mixed trend among other Asian pregnant women, however, GWG among Indian pregnant women was found to be inadequate.

Evidences from literature has showed over 40% of Indian women are underweight when they begin pregnancy. Currently Poshan Abhiyan and other maternal health programmes focussing on antenatal care, nutritional and health education, food supplementation, etc. have various implementation challenges. Several shortcomings such as resource constraints, barriers to behaviour change, inadequate access to health services, policy and governance have resulted into poor maternal and child health outcomes in India. There are no established guidelines for prevention, screening and management of obesity during pregnancy.

The Institute of Medicine (IOM) guidelines recommend a specific range of weight gain during pregnancy based on pre-pregnancy weight status but there are no specific clinical guidelines concerning to Indian women. Lately, an AIIMS-DST Initiative in association with FOGIS (The Federation of Obstetric and Gynaecological Societies in India) has attempted to frame clinical practice guidelines for weight management in postpartum women.

The silent pandemic of obesity is on a rise and there is a need for comprehensive lifestyle interventions including dietary modifications, physical activity and behavioral therapy among the pre-natal, natal and post-natal period. However, literature on burden of overweight/obesity and guidelines on weight management during and after pregnancy are lacking in Indian context. The primary prevention of adult obesity requires combined efforts by stakeholders at various societal levels, based on the knowledge from multiple disciplines.

There is a paucity of literature regarding population based studies on GWG and PPWR. Majority of the included studies in our review were hospital-based which could have led to a lack of representativeness of the pregnant women from the community and subsequently altered pooled results. Therefore, results from our review may not be generalizable to the whole population and there is a need for larger community-based studies.

To the best of our knowledge, this is the first comprehensive review to summarize pooled mean of GWG and the proportion of women with excessive gestational weight gain among the Indian population. To improve the strength of the review, three databases were searched and all the published and eligible studies were included without any time restrictions. An objective and structured qualitative assessment was conducted for all the included studies using the Newcastle-Ottawa Scale. However, our review has certain limitations. As grey literature and articles of other languages were not included in the search, there is a possibility of missing a few studies in the review. Statistically significant ‘between-study’ variability and high heterogeneity were found among the included studies, which was not explained by the region and guidelines. There was a difference in sample size, study design, and quality across the included studies, and due to this reliability and generalizability of the results are compromised. Studies following no standardized criteria for GWG were also included in the review. The
majority of the studies in the review were from urban areas, implying better healthcare accessibility and availability, good maternal education, and better financial conditions. This excludes a major proportion of pregnant women from rural parts of India. Despite the significant health impact of excessive gestational weight gain and postpartum weight retention on the health of the mother and child and their implications on the increasing burden of cardiometabolic syndrome, little is known about their prevalence and associated risk factors in the Indian setting. There is a need for larger population based surveys among Indian women to obtain adequate, appropriate and complete health related information about weight changes during and after pregnancy. A plan for effective public health evidence based interventions with strong political commitment focussing on the weight management during preconception, pregnancy and postpartum period is required.

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Author contributions
NP: conception of the study, protocol development, acquisition of data, drafting this article and final approval; VL: protocol development, acquisition of data, data analysis & interpretation and final approval; HS: conception of study, critical revisions and final approval; SL: conception of the study, protocol development, acquisition of data, data interpretation, critical revisions and final approval.

Declaration of competing interest
The author and co-authors declare no conflict of interest regarding the conduct and publication of this study.

Appendix A. Supplementary data
Supplementary data to this article can be found online at https://doi.org/10.1016/j.cegh.2023.101364.

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