Weight and height measurement: potential impact in obstetric care

Emma Jeffs, Benjamin Sharp, Joanna Gullam, Helen Paterson

Abstract

**Aim** To assess the accuracy of reported weight and height in a pregnant population.

**Methods** Participants were recruited when attending their nuchal translucency scan if they attended with an ‘antenatal screening for Down syndrome and other conditions’ laboratory form (used for the maternal serum screening in the first trimester (MSS1) blood test) that had weight and/or height recorded. Participants’ weight and height were measured by trained recruitment centre staff and body mass index (BMI) was calculated. Differences in reported (MSS1) and measured weight, height and BMI were analysed using Bland-Altman plots.

**Results** 248 women participated. Only 23% (n=56) of participants had a weight recorded on the MSS1 laboratory form that was within ± 0.5 kg of measured weight: 62% (n=155) had an under-reported weight, and 15% (n=37) an over-reported weight. 30% (n=74) of participants had a correctly reported height: 26% (n=63) an under-reported height, and 44% (n=107) an over-reported height. 6% (n=14) of participants had a correctly reported BMI: 69% (n=166) had an under-reported BMI, and 25% (n=60) an over-reported BMI. 17% of participants (n=40) were incorrectly classified by BMI category based on MSS1 data.

**Conclusion** Our study suggests that there are considerable inaccuracies in the recording of weight and height during pregnancy in New Zealand. This results in a false reduction in BMI in many women which can affect clinical care.

It is widely reported in the literature that self-reported data tend to underestimate weight and overestimate height. Since weight and height are two of the most commonly used anthropometric measurements in clinical practice, inaccuracies in the measurement or recording of these indices could result in errors in clinical management. Throughout pregnancy weight, height and hence body mass index (BMI = weight [kg]/height² [m²]) are routinely used to inform care.

Weight and BMI can significantly affect clinical care during pregnancy. Both inadequate and excess weight gain in pregnancy can affect a woman’s own health, as well as that of her infant. In view of this, it is recommended women be advised on ideal weight gain in pregnancy according to their pre-pregnancy or early pregnancy BMI (Table 1), and that weight gain throughout pregnancy be monitored.

At between 9 weeks and 13 weeks 6 days gestation, pregnant women are routinely offered an antenatal screen for ‘Down syndrome and other conditions’. This screening test includes the maternal serum screening in the first trimester (MSS1) blood test, which incorporates maternal weight in its prediction of risk algorithm for ‘Down syndrome and other conditions’, and the nuchal translucency (NT) scan.
The ‘Guidelines for Consultation with Obstetric and Related Medical Services’ ("Section 88") recommend women with a BMI >35 be referred for consultation with an obstetric specialist, and that for women with a BMI >40 there is transfer of care to the specialist and anaesthetic consultation.11 It is also recommended that customised growth charts (‘GROW’ charts, accessed at: www.gestation.net) which consider maternal weight and height in their generation be used in pregnancy as these help to improve the recognition of small for gestational age (SGA) infants.12

Table 1. 2009 Institute of Medicine Weight Gain in Pregnancy Guidelines

<table>
<thead>
<tr>
<th>BMI category</th>
<th>BMI range (kg/m²)</th>
<th>Recommended total weight gain (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>12.5–18</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5–24.9</td>
<td>11.5–16</td>
</tr>
<tr>
<td>Overweight</td>
<td>25–29.9</td>
<td>7–11.5</td>
</tr>
<tr>
<td>Obese</td>
<td>≥30</td>
<td>5–9</td>
</tr>
</tbody>
</table>

* Pre-pregnancy or early pregnancy BMI.

Figure 1. Antenatal screening for Down syndrome and other conditions laboratory form
Therefore, inaccurate documentation of weight and height (hence BMI) may affect the accuracy of education provided to women, the information given to women and their healthcare providers, and routine monitoring. When completing the ‘booking form’ at the beginning of pregnancy, there is evidence to suggest that women are being asked to report their weight and height, rather than being measured.\textsuperscript{13}

Weight and height are recorded on the ‘Antenatal screening for Down syndrome and other conditions’ laboratory form\textsuperscript{10} (MSS1 laboratory form, Figure 1). Women often have blood for the MSS1 test taken when attending their NT scan, if the testing centre is equipped to do so. This provides the opportunity to compare reported weight and height (on the MSS1 laboratory form) with measured weight and height at this time.

The aim of this study was to assess the accuracy of reported weight and height in a population of pregnant women, by comparing weight and height on the MSS1 laboratory form with measured weight and height at the time of the NT scan.

\textbf{Methods}

Participants were taking part in a larger study that aimed to describe women’s knowledge and perceptions of the risks of excess weight in pregnancy.\textsuperscript{14} Recruitment was undertaken at four community radiology centres in Christchurch, New Zealand in 2011. Participants were recruited when attending their NT scan at between 11 weeks and 13 weeks 6 days gestation. Participants who presented with a MSS1 laboratory form with weight and/or height recorded and who consented to have their weight and height measured were included in this study. Once recruited, participants were weighed on calibrated SECA 813 electronic scales, and had their height measured using SECA 206 or SECA 217 stadiometers.

Instruction on the correct use of both the scales and stadiometers was provided by research staff according to instructions given in the 2008/09 Adult Nutrition Survey \textit{(Accessed at: www.health.govt.nz/publication/methodology-report-2008-09-nz-adult-nutrition-survey}, page 28). The weight and height documented on the MSS1 laboratory form were recorded for comparison. MSS1 weight was considered correct if within ± 0.5 kg of measured weight. Height in metres was rounded to two decimal places (dp). Raw data was used to calculate BMI to 1dp for both weight and height recorded on the MSS1 laboratory form and that measured at the time of scan form using the equation: \(\text{BMI} = \frac{\text{weight (kg)}}{\text{height}^2 (\text{m}^2)}\). Differences in weight, height and BMI were analysed using Bland-Altman Plots and descriptive statistics were calculated, with the support of a biostatistician, using Microsoft Excel 2011.

\textbf{Results}

Data were available for both measured and MSS1 data for 248 participants for weight, 244 participants for height, and 240 participants for BMI (not all participants consented to having their height and weight measured, or had height and weight recorded on the MSS1 laboratory form).

The difference in weight measurements was from -15 kg (over-reported) to +12 kg (under-reported). In total, 62\% (n=155) of participants had an under-reported weight on the MSS1 laboratory form. This is highlighted in Figure 2 as the majority of the data points (◆) are above the X-axis, representing a positive difference which is indicative of under reporting on the MSS1 laboratory form.
As measured weight increased, weight recorded on the MSS1 laboratory form became more discrepant, such that participants were more likely to have an under-reported weight. Only 23% (n=56) of participants had a weight recorded on the MSS1 laboratory form that was within ± 0.5 kg of measured weight, and 15% (n=37) had an over-reported weight.

The difference in height measurements was from -13 cm (over-reported) to +13 cm (under-reported) (Figure 3). Overall, 26% (n=63) of participants had an under-
reported height on the MSS1 laboratory form, 30% (n=74) a correctly reported height, and 44% (n=107) an over-reported height.

**Figure 4. Bland-Altman plot of body mass index (BMI)**

![Bland-Altman plot](image)

The difference in BMI measurements was from -3.8 kg/m² (over-reported) to +5.2 kg/m² (under-reported) (Figure 4). Overall, if based on reported not measured data, 69% (n=166) of participants would have had an under-reported BMI, 6% (n=14) a correctly reported BMI, and 25% (n=60) an over-reported BMI.

As measured BMI increased, BMI calculated from the MSS1 laboratory form data became more discrepant, such that participants were more likely to have a BMI that was less than measured BMI, and to a greater magnitude.

According to the MSS1 laboratory form data, 40 participants (17%) would have been incorrectly classified by BMI classification when compared with measured data. Twelve (26%) obese women would have been misclassified based on MSS1 data.

**Discussion**

This study identifies that documented height and weight recorded on the MSS1 laboratory form are not accurate at the time of the NT scan. Inaccurate recording or measurement of weight and height affects BMI calculation and BMI plays a significant role in recommended clinical care, specialist consultation and referrals in pregnancy.

In June 2012, the New Zealand Perinatal and Maternal Mortality and Morbidity Review Committee (PMMRC) recommended all women be advised on healthy weight gain in pregnancy according to their pre-pregnancy or early pregnancy BMI. The 2009 Institute of Medicine (IOM) guidelines for healthy weight gain in pregnancy (Table 1) have been internationally accepted and are the guidelines recommended by the PMMRC.
Weight gain in excess of the IOM guidelines (regardless of baseline BMI) has been associated with an increased risk for pregnancy-associated hypertension, gestational diabetes mellitus (GDM), complications during labour and delivery, postpartum weight retention and subsequent maternal obesity.\(^7\)

An incorrect BMI could result in the failure to recognise a pregnancy as high risk and a woman being wrongly advised on appropriate weight gain, contributing to unnecessarily increased risk in pregnancy. Furthermore, if weight is not routinely monitored in pregnancy, inadequate or excess weight gain may not be identified and this could further contribute to increased pregnancy risk.\(^7\)

The Guidelines for Consultation with Obstetric and Related Medical Services ("Section 88"),\(^11\) which outline Crown payments to maternity providers providing primary maternity services, recommend women with a BMI >35 be referred for consultation with an obstetric specialist. For women with a BMI >40 it is recommended there is transfer of clinical responsibility and anaesthetic consultation.\(^11\)

A number of adverse pregnancy outcomes are associated with maternal obesity (BMI \(\geq 30\)) and these are well described within the literature. Such complications include GDM,\(^15-21\) hypertensive disorders of pregnancy,\(^15,16,18,20,22\) pre-eclampsia,\(^17,21,23,24\) preterm delivery,\(^25\) post-dates pregnancy,\(^19,26\) induction of labour,\(^15,20-23,26,27\) caesarean section delivery,\(^15-20,23,24,26\) infection,\(^21,22\) and haemorrhage.\(^17,20,21,23,26\)

Risk associated with maternal obesity typically occurs as a continuum: there is increased likelihood of negative health outcome as maternal excess weight increases.\(^28\) In 2010 in New Zealand, BMI data was available for 92% of mothers of perinatal deaths.\(^8\) Over half (51.2%) of the mothers of perinatal deaths were overweight or obese, and 27% were obese.\(^8\) Thus, it is important that such high risk women are identified and referred appropriately.

GROW (gestation related optimal weight) charts are customised antenatal growth charts, recommended for use in all pregnancies.\(^12\) The chart is based on the calculation of an individualised weight standard for the duration of the pregnancy, adjusted for the physiological variables of maternal weight, height, parity and ethnicity.

If weight or height is incorrectly measured or reported it may lead to an incorrect GROW chart being created. Clinically, this could result in the under diagnosis of SGA and the over diagnosis of large for gestational age (LGA). This is significant as SGA is associated with adverse outcomes including prematurity and stillbirth, whilst LGA might be the first presentation of GDM, which can present with both a large baby and polyhydramnios.\(^12,15\)

In February 2010 quality improvements to antenatal screening for ‘Down Syndrome and other conditions’ were introduced nationally in New Zealand.\(^9\) These recommend a first trimester combined screen which includes the MSS1 laboratory test taken at between nine weeks and 13 weeks 6 days gestation, analysing levels of pregnancy-associated plasma protein-A (PAPP-A) and beta human chorionic gonadotrophin (beta hCG), combined with an ultrasound scan, completed between 11 and 13 weeks six days, that measures the nuchal translucency.\(^9\) A risk assessment is calculated incorporating both of these results.\(^9\) Weight influences the risk assessment by means of a dilution effect on the PAPP-A and beta hCG.\(^29\) As such, an incorrect weight
reported on the MSS1 laboratory form could lead to the over or underestimation of risk (Table 2). If a woman is assessed as being of high risk (i.e. risk greater than 1:300) she will be offered an amniocentesis test which comes with a one percent risk of pregnancy loss. 

Table 2. An example of the impact of weight on risk prediction for Trisomy 21 (Down syndrome)

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Risk T21a</th>
<th>Uncorrected 0.43b PAPP-A MoMd</th>
<th>Uncorrected 3.40c Beta hCG MoM corrected for weight</th>
<th>NT MoM</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>High risk</td>
<td>0.29</td>
<td>2.62</td>
<td>0.9</td>
</tr>
<tr>
<td>51</td>
<td>95</td>
<td>0.34</td>
<td>2.88</td>
<td>0.9</td>
</tr>
<tr>
<td>61</td>
<td>240</td>
<td>0.4</td>
<td>3.16</td>
<td>0.9</td>
</tr>
<tr>
<td>71</td>
<td>280</td>
<td>0.46</td>
<td>3.46</td>
<td>0.9</td>
</tr>
<tr>
<td>81</td>
<td>320</td>
<td>0.54</td>
<td>3.79</td>
<td>0.9</td>
</tr>
<tr>
<td>91</td>
<td>370</td>
<td>0.63</td>
<td>4.16</td>
<td>0.9</td>
</tr>
<tr>
<td>101</td>
<td>410</td>
<td>0.73</td>
<td>4.56</td>
<td>0.9</td>
</tr>
<tr>
<td>111</td>
<td>460</td>
<td>0.85</td>
<td>5</td>
<td>0.9</td>
</tr>
<tr>
<td>121</td>
<td>580</td>
<td>0.97</td>
<td>5.43</td>
<td>0.9</td>
</tr>
</tbody>
</table>

a) T21: Trisomy 21, Down syndrome
b) Uncorrected MoM for PAPP-A for this patient
c) Uncorrected MoM for beta hCG for this patient
d) Multiple of median
e) Information supplied


If this woman was recorded as having a weight of 71kg, she would have been classified as being of high risk for Trisomy 21. If her weight was recorded as 81kg, she would have been assessed as being lower risk.

Note: Example presented with permission from: National Screening Unit, Ministry of Health, New Zealand

Whilst this study presents descriptive statistics pertaining to the measurement and recording of weight and height within pregnancy, it must be appreciated that each point on Figures 2–4 represents a woman whose pregnancy care may have been affected by inaccurate measurement or recording of weight or height.

A number of participants, particularly the 17% for whom an inaccurate BMI classification could have been given, could potentially have had care not in accordance with recommended practice (example: Table 3).
Table 3. An example of potential difference in care: a participant from this study

<table>
<thead>
<tr>
<th>Participant # 419</th>
<th>Measured data</th>
<th>MSS1 data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age: 25 years</td>
<td>Weight (kg)</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Height (m)</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>BMI (kg/m²)</td>
<td>31.3</td>
</tr>
<tr>
<td></td>
<td>BMI category</td>
<td>Obese</td>
</tr>
<tr>
<td></td>
<td>IOM weight gain recommendation</td>
<td>5–9 kg</td>
</tr>
<tr>
<td></td>
<td>MSS1 risk (Down Syndrome)</td>
<td>Low risk</td>
</tr>
</tbody>
</table>

Study limitations—The main research, of which this was a sub-study, was not originally powered to consider the statistics presented in this paper and consequently this study reports descriptive statistics.

This study did not investigate the length of time between the Lead Maternity Carer (LMC) completing the MSS1 laboratory form and participants attending the NT scan, it was assumed that women attending their NT scan with the MSS1 laboratory form would have been intending to have their bloods taken at the time of the scan.

The period of time between completion of the MSS1 laboratory form and the NT scan may have resulted in small differences in weight. The IOM, however, note that average weight gain in the first trimester is less than 2 kg. This time difference would not affect the findings regarding height.

Conclusion—Weight, height and BMI play an important role in pregnancy care and this study presents evidence to suggest the measurement of these indices is not being correctly conducted, or that such indices are being estimated and not measured in all cases. This results in a false reduction in BMI which can affect clinical care.

Implications for practice—All women of childbearing age should have a weight measured and documented, and BMI calculated as part of routine clinical practice. When pregnant, BMI should be calculated from measured weight and measured height at booking/first visit (ideally before 10 weeks gestation) by the LMC.

Competing interests: Nil.

Author information: Emma Jeffs, Research Dietitian, Department of Women’s and Children’s Health, University of Otago, Dunedin; Benjamin Sharp, Consultant Obstetrician and Gynaecologist and Senior Clinical Lecturer, Christchurch Women’s Hospital, Christchurch; Joanna Gullam, Consultant Obstetrician and Gynaecologist and Senior Clinical Lecturer, Department of Obstetrics and Gynaecology, University of Otago, Christchurch; Helen Paterson, Consultant Obstetrician and Gynaecologist and Senior Lecturer, Department of Women’s and Children’s Health, University of Otago, Dunedin

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Correspondence:
Dr Helen Paterson, Senior Lecturer and Obstetrician and Gynaecologist, Department of Women's and Children's Health, Dunedin School of Medicine, University of Otago, PO Box 913 Dunedin, New Zealand. Fax: +64 (0)3 4747620; email: helen.paterson@otago.ac.nz

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