Validation of the London Measure of Unplanned Pregnancy among pregnant Australian women

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Abstract

Introduction

Globally, over half of pregnancies in developed countries are unplanned. Identifying and understanding the prevalence and complexity surrounding pregnancy preparation among Australian women is vital to enable sensitive, responsive approaches to addressing preconception and long-term health improvements for these women with varying motivation levels.

Aim

This study evaluated the reliability and validity of a comprehensive pregnancy planning/ intention measure (London Measure of Unplanned Pregnancy) in a population of pregnant women (over 18 years of age) in Australia.

Methods

A psychometric evaluation, within a cross-sectional study comprising cognitive interviews (to assess comprehension and acceptability) and a field test. Pregnant women aged over 18 years were recruited in early pregnancy (approximately 12 weeks' gestation). Reliability (internal consistency) was assessed using Cronbach's alpha, corrected item-total correlations and inter-item correlations, and stability via a test-retest. Construct validity was assessed using principal components analysis and hypothesis testing.

Results

Six women participated in cognitive interviews and 317 in the field test. The London Measure of Unplanned Pregnancy was acceptable and well comprehended. Reliability testing demonstrated good internal consistency (alpha = 0.81, all corrected item-total correlations >0.20, all inter-item correlations positive) and excellent stability (weighted kappa = 0.92). Validity testing confirmed the unidimensional structure of the measure and all hypotheses were confirmed.

Conclusions

The London Measure of Unplanned Pregnancy is a valid and reliable measure of pregnancy
planning/intention for the Australian population. Implementation of this measure into all
maternity healthcare, research and policy settings will provide accurate population-level
pregnancy planning estimates to inform, monitor and evaluate interventions to improve pre-
conception health in Australia.

Introduction

Global estimates report that over half of all pregnancies in high income countries are
unplanned [1]. Unplanned pregnancies are associated with suboptimal reproductive health-
care engagement and preconception health behaviors, as well as a range of adverse maternal
and neonatal outcomes including pregnancy loss, low birth weight and neonatal mortality [2–
5]. Conversely, planning for pregnancy is predictive of positive behavior change such as pre-
conception smoking cessation and commencement of folic-acid and multivitamin supplemen-
tation [6].

The preconception period, 2–3 months prior to pregnancy [5], represents a critical time in
which the health behaviors of reproductive-aged women and men can influence their general
wellbeing, reproductive health, pregnancy outcomes and the health of their family and future
generations [7]. These behaviors include: changing eating practices and micronutrient supple-
mentation aligned with national guidelines; undertaking regular physical activity; achieving a
healthy weight; smoking, recreational drug and alcohol cessation; chronic disease manage-
ment; health screening; and updating immunizations [8]. Yet limited awareness of preconcep-
tion health remains a key barrier to engagement in these healthy behaviors in both women and
men [5]. This contributes to a missed opportunity to optimize health in preparation for preg-
nancy that benefits women's own wellbeing and that of their child [8]. In addition, prior stud-
ies have shown that women experiencing socio-economic disadvantage, low educational
attainment, unemployment, who are <25 years of age, single or overseas-born are more likely
to experience unplanned pregnancies [9–11]. Identifying and more deeply understanding the
detail surrounding pregnancy planning and preparation will enable a more targeted and tai-
lored approach to addressing preconception health improvements for women with varying
levels of planning, health risks and motivations.

In Australia, 310,247 women gave birth in 2016 [12]. The average age of all these women
was 30.5 years, 29.0 years for first-time mothers and most mothers were in a marital relation-
ship (66%). Nearly all births (97%) occurred in hospitals, most commonly in public hospital
settings (74%). Whilst abortion is legal (or decriminalized) throughout Australia, abortion
laws vary between different states [13]. Information available on abortion rates is limited, how-
ever, recent data collected in the state of South Australia estimated induced abortion rates of
13.5 per 1,000 women aged 15–44 years in 2015, with most of these terminations performed in
metropolitan public hospitals [14]. Research has described that approximately half of women
reporting unplanned pregnancies choose to parent, approximately one-third choose abortion,
a few (2%) opt for adoption and 13% of women experience a miscarriage [15].

Pregnancy planning and intention is a complex multifaceted concept and an unplanned
pregnancy may not mean an unwanted pregnancy [16]. To date, Australian studies have used
a variety of measures to assess pregnancy planning [9, 11] including the London Measure of
Unplanned Pregnancy (LMUP) [17, 18]. The LMUP is a comprehensive measure of pregnancy

intention which aims to accurately capture the nuances in behaviors and feelings surrounding conception [19]. However, it is yet to be validated in the Australian context. To address this gap, the current study adapts the LMUP and evaluates its suitability, reliability and validity to assess pregnancy planning in a population of pregnant women living in Australian.

Methods

To evaluate the LMUP's psychometric properties in Australia, Classical Test Theory item analysis, consistent with prior LMUP evaluation methodology [19], was employed. The LMUP evaluation was embedded within a cross-sectional study questionnaire examining pregnancy intention and preparation behaviors.

The instrument—LMUP

The LMUP is a self-administered retrospective measure including six items (questions) assessing the extent of pregnancy planning/intention of current or recent pregnancies [19]. Originally developed in the United Kingdom (UK), the tool has been validated across different countries and in several language versions [20–27]. The items relate to contraceptive use, pregnancy timing, intentions, desire, partner influence and preparation. A score of zero, one or two can be achieved for each item (Table 1 provides a summary of LMUP items and response options). Scores are combined to calculate an overall pregnancy intention score ranging from zero to 12, with increasing scores representing higher degrees of planning/intention. Whilst the scale is best used in a continuous form, for population estimates the scores can be divided into three classifying groups: 10–12 (planned), 4–9 (ambivalent); and 0–3 (unplanned) [19]. If a binary score for the LMUP is used, scores should be classified as ≥10 being planned and 0–9, unplanned [28].

Adaptation of the LMUP for the Australian context. Prior to cognitive interviews (described below) two response options were added to item six relating to pregnancy preparation including whether women 'took iodine' or 'took vitamin D' (see Australian LMUP, http://measure.ascody.co.uk/lmupaustralia.htm). Iodine was added in accordance with

Table 1. Frequencies of LMUP items and response options (n = 317).

Item	Response options	Scores	
		n	%
1. Contraception	0, always used contraception	4	1.3
	1, used sometimes or failed at least once	27	8.5
	2, did not use contraception	286	90.2
2. Timing	0, wrong time	3	0.9
	1, ok, but not quite right time	72	22.7
	2, right time	242	76.3
3. Intention	0, did not intend pregnancy	37	11.7
	1, intentions kept changing	40	12.6
	2, intended pregnancy	240	75.7
4. Desire	0, did not want baby	8	2.5
	1, mixed feelings about having baby	53	16.7
	2, wanted a baby	256	80.8
5. Partner	0, never discussed getting pregnant	5	1.6
	1, discussed but did not agree to get pregnant	40	12.6
	2, agreed to get pregnant	272	85.8
6. Preparation	0, no health actions	90	28.4
	1, one health action	59	18.6
	2, 2 or more health actions	168	53.0

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recommendations by the Australian National Health and Medical Research Council [29] and the Australian general practice preconception care guidelines [30]. Consideration of vitamin D deficiency was also clinically relevant at the time as women's levels were tested as part of routine antenatal care in the state of Victoria. The addition of these options did not affect the overall scoring.

Settings, recruitment and participants

Women were recruited in early pregnancy through Monash Health maternity services, a large public maternity service in Victoria, Australia and through the member database of one of the largest Australian national private health insurers, Medibank Private Limited (Medibank).

Monash Health is one of the largest Australian healthcare services, with approximately 9,000 births in 2017–18 across the catchment, catering to a diverse population including 62% of women born overseas. In Australia, women have the option to pay for private healthcare in pregnancy; and while 74% of hospital births in Australia occur in public hospitals, many women (26%) elect to give birth in private hospitals [12]. To enable the inclusion of a broad national cross-section of reproductive age women, Medibank, one of the principal private healthcare providers in Australia providing obstetrics cover for approximately 20,000 Australian births annually, was also engaged in the study.

Prior to the study's commencement, A.Y.L, C.L.H and L.J.M met with and presented the study to the clinic midwives and staff to establish an appropriate recruitment process at the public maternity service. A collaboration was established with the private health insurer and the recruitment process was co-developed with members of the research team (C.L.H, J.A.B, and H.T).

Ethics. Ethics approval for this study was granted by the Monash Health (RES-17-0000-087A) and Monash University (Project no. 10370) Human Research Ethics Committees. All women provided informed consent.

Monash health—Public maternity service. A study invitation flyer was mailed to all women attending the public maternity service clinic over the study period (August 2017 to March 2018) before their first antenatal appointment. Women were eligible to take part if they were pregnant, aged over 18 years, attending the public maternity services for their first antenatal visit or who received the invitation flyer and expressed interest in participating prior to their first maternity appointment. Women were excluded if they were unable to communicate or comprehend sufficiently in English.

A secure link to complete the questionnaire online or a hard copy was provided. As gratitude, in recognition of participation, all women at the public maternity service were placed in the draw to receive a $100AUD gift card.

Medibank—Private health system. Eligible women were private health insurance members, aged 18–40 years who had taken out, or upgraded their private health cover to include obstetrics within the 12 months prior to recruitment commencement (January 2018), and who self-identified as being pregnant. The eligible age range was defined by the health insurer.

A database of eligible members was provided by the health insurer. A co-developed invitation for participation was emailed to all eligible women explaining the voluntary nature of participation. Women opted-in to the study providing implied consent by following the link and completing the online questionnaire.

Phase 1: Pre-testing—Cognitive interviews

Cognitive interviews [31] were conducted through the public maternity service to pre-test the LMUP. Women completed the questionnaire, followed by the interview where the research

used probing techniques to determine appropriateness and comprehension of the questions by women. There is no specified minimum number of interviews required for testing a question-naire, however, small numbers have been found to be sufficient, with a maximum of 12–15 interviews recommended [32]. These interviews were conducted by the research lead (A.Y.L) as individual face-to-face or telephone sessions which ran for approximately 30 minutes. Detailed notes were taken and any changes were discussed with members of the research team. Initial testing and re-testing was conducted. No concerns were raised by women regarding the comprehension of the LMUP questions during interview and no changes were made.

Phase 2: LMUP–Validity and reliability testing

Following recruitment for cognitive interviews, women recruited into the main study con-sented to complete the initial LMUP (embedded within the broader cross-sectional study ques-tionnaire) and a repeat of the LMUP only (online or hard copy) was sent two weeks later to assess test-retest reliability. Recruitment for the test-retest cohort ceased once sufficient num-bers (~100) had been reached [33, 34]. The overall sample size exceeded minimum recommen-dations for validation studies [35]. The remaining women completed the LMUP embedded within the questionnaire at one time point only.

Demographic information. Self-reported demographics were collected. Age was calcu-lated from women's date of birth. Women were asked if they had any children and if so, how many. Relationship status at 3 months before pregnancy was asked and included the following response options: married, defacto, never married, widowed, divorced, separated. Place of birth was asked with response options including: Australia, United Kingdom, India, Sri Lanka, New Zealand, Afghanistan, Philippines, Mauritius, China, South Africa or other. Women were asked to indicate their main employment status in the year before pregnancy as: full time paid work, part time or casual paid work, work without pay [e.g. in a family business], home duties only–no paid work, studying, unemployed–looking for work, unpaid voluntary work, unable to work due to sickness or injury or other. Women provided their postal code and were asked to indicate their highest level of education (response options included: no post-school qualifi-cation, Certificate III/IV, Advanced Diploma and Diploma, Bachelor Degree, Graduate Diploma and Graduate Certificate or Postgraduate Degree [e.g. Masters, PhD]). Response cat-egories were combined for analysis (see Table 2). Additional information was obtained from the public hospital medical records including: women's gestation at first visit, gravida, parity, previous birth outcomes and postal code. A woman's socio-economic status (SES) was esti-mated by aligning her postal code with a corresponding score (decile) defined by the Austra-lian Socio-Economic Indexes for Areas (SEIFA), Index of Relative Socio-Economic Disadvantage [36]. SEIFA deciles were estimated based on a combination of variables from the National Census e.g. income, education and unemployment. An area (determined by postal code) receives a score (deciles) ranked on a scale of disadvantage relative to other areas. Deciles 1–3 were classified as low SES, 4–7 middle SES and 8–10 high SES. SEIFA is used as standard indicator of SES in Australia making it comparable with other studies [17].

Statistical analysis

Data analysis was performed following the Classical Test Theory-based approach using SPSS version 25 (Armonk, New York) and STATA version 14 (College Station, Texas).

Acceptability and targeting. Acceptability of measure was initially examined through cognitive interviews and further determined by assessing missing data rates, with lower rates (<5%) indicating greater acceptability [37]. Distribution of total LMUP scores were checked to examine whether the full range of scores had been captured as an indication of targeting of

Table 2. Characteristics of women completing the LMUP compared to the national antenatal populations.

	Total n = 317	LMUP test-retest (twice) n = 131	LMUP non-retest (once only) n = 186	Comparison of LMUP test-retest and non-retest groups	National pregnant population^
Age (years)	n = 284	n = 131	n = 153	P = 0.95	
Mean (SD)*	30.1 (4.7)	30.1 (4.6)	30.1 (4.8)		30.5
	n (%)	*n (%)*	*n (%)*		*n (%)*
Age group	n = 284	n = 131	n = 153	P = 0.16	
<25	36 (12.7)	17 (13.0)	19 (12.4)		44,816 (14.5)
25–29	91 (32.0)	36 (27.5)	55 (35.9)		83,667 (27.0)
30–34	107 (37.7)	58 (44.3)	49 (32.0)		110,946 (35.8)
>35	50 (17.6)	20 (15.3)	30 (19.6)		70,776 (22.8)
Children	n = 287	n = 131	n = 156	P = 0.70	
0–2	270 (94.1)	124 (94.7)	146 (93.6)		n/a
≥3	17 (5.9)	7 (5.3)	10 (6.4)		n/a
Relationship status	n = 273	n = 131	n = 142	P = 0.51	
Married/ De facto	255 (93.4)	121 (92.4)	134 (94.4)		N/A (66 married) [40]
*Unmarried**	18 (6.6)	10 (7.6)	8 (5.6)		n/a
Place of birth	n = 273	n = 131	n = 273	P = 0.74	
Australia	157 (57.5)	74 (56.5)	83 (58.5)		201,984 (65.1)
Outside Australia	116 (42.5)	57 (43.5)	59 (41.5)		106,572 (34.4)
Previous live birth	n = 287	n = 131	n = 156	P = 0.01	
Yes	148 (51.6)	78 (59.5)	70 (44.9)		176,671 (56.8)
No	139 (48.4)	53 (40.5)	86 (55.1)		132,842 (42.8)
Education	n = 273	n = 131	n = 142	P = 0.43	
Post-secondary school	228 (83.5)	107 (81.7)	121 (85.2)		n/a
School only	45 (16.5)	24 (18.3)	21 (14.8)		n/a
Employment	n = 273	n = 131	n = 142	P = 0.83	
Paid employment	211 (77.3)	102 (77.9)	109 (76.8)		n/a
Unpaid employment/ unemployed	62 (22.7)	29 (22.1)	33 (23.2)		n/a
Public/ private healthcare	n = 317	n = 131	n = 186	n/a	
Private	92 (29.0)	n/a	92 (49.5)		26%
Public	225 (71.0)	131 (100)	94 (50.5)		74%
SIEFA	n = 283	n = 131	n = 152	P = 0.74	
Higher level disadvantage (Decile 1–5)	87 (30.7)	39 (29.8)	48 (31.6)		n/a
Lower level disadvantage (Decile 6–10)	196 (69.3)	92 (70.2)	104 (68.4)		n/a

Note: Total *n* may vary due to missing data.

^Supplementary tables for Australia's mothers and babies 2016—in brief [12].

*Data for age was reported as mean (standard deviation), all other data were presented as frequencies (percentages) and analyzed using the student's t-test or chi-square.

**Never married/ widow/ divorced /separated.

Abbreviations: LMUP = London Measure of Unplanned Pregnancy, SIEFA = Socio-Economic Indexes for Areas, SD = Standard deviation.

the measure. The percentage of women that selected each response option for an item (item-endorsement) was examined to provide information about item discrimination [38].

Reliability. Reliability (internal consistency) was examined using the Cronbach's alpha (α) statistic (where a score >0.7 was used to indicate acceptable reliability) and corrected item-total correlations (where <0.2 indicates items contribute little to the homogeneity of the scale) [38]. Inter-item correlations were also examined to check that they were positively correlated. Test-retest reliability was measured with a sub-sample of the population using the weighted kappa (κ) to reflect the stability of women's scores. Agreement scores were classified as moderate (0.41–0.60) or substantial (0.61–0.80), to near perfect (0.81–1.00) [39].

Validity. Construct validity was evaluated by principal component analysis (PCA) and hypothesis testing. PCA assessed the internal structure of the LMUP by testing whether all items loaded onto one component (unrotated, with an Eigenvalue >1), demonstrating that the LMUP is measuring a single underlying construct. To test whether the LMUP behaved as it should, hypotheses supported by prior pregnancy intention literature and LMUP validation studies were tested [9, 17, 19, 20]. Based on prior literature, it was hypothesized that: LMUP scores will be lower (more unplanned) in women with more live children (≥3) and women who were not in a relationship (married or de facto) [9, 17, 19, 20]. Continuous variables were presented as mean± standard deviation (SD) or median and inter-quartile range (IQR) as appropriate. Categorical variables were presented as frequencies (percentages). The student's t-test or chi-square was used as appropriate to examine any differences between demographics of women who completed the retest and those that did not and those in the public and private groups. As LMUP scores followed a non-parametric distribution, the Mann Whitney U test was used to assess hypotheses. P values <0.05 were considered statistically significant. Criterion validity, comparing newly developed psychometric tools with established 'gold standard' measures of the same construct, was not possible due to the absence of prior tools [19].
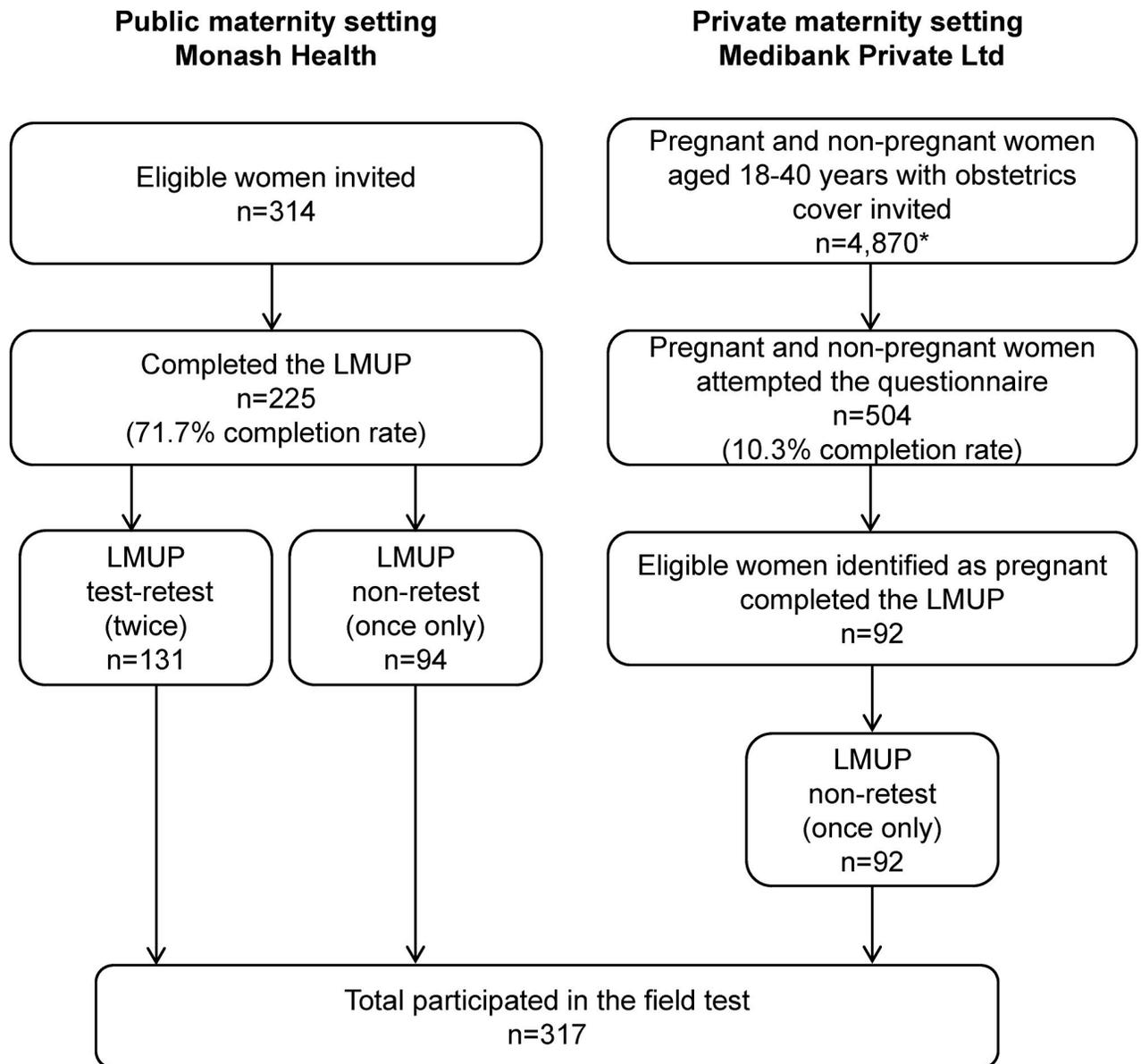
Results

Samples and characteristics of participating women

Cognitive interviews were conducted with six pregnant women recruited through the public maternity service. The mean±SD gestation of these women at recruitment (first antenatal visit) was 12.5±1.1 weeks, with a mean age of 33.5±1.4 years. All six women were in a relationship (married n = 5, de facto n = 1), all had children and a post-secondary school education and three were Australian born. In the year before pregnancy, four of these women were unemployed.

The LMUP field test was completed by 317 pregnant women in the public (n = 225) and private (n = 92) maternity care systems. Of the women from the public hospital cohort only, 314 women were eligible and initially recruited to participate in the study (225 of these women in the public hospital who agreed to participate completed the questionnaire, a 71.7% completion rate), 131 of which also completed the test-retest component. Women recruited through the private health insurer completed the embedded LMUP once only. An initial email was sent to eligible women in the Medibank database (n = 4,870 including both pregnant and non-pregnant women), 56.8% of these women opened the original email invitation, 13.5% opened the questionnaire and 10.3% (n = 504) attempted the overall questionnaire. For the purpose of this study only women who identified as being pregnant and who completed the LMUP questions were included, of which there were 92. See participation flow diagram, Fig 1.

The mean±SD gestation of women from the public maternity service at the time of recruitment (first antenatal visit) was 8.12±3.7 weeks. Data were not available for women recruited through the private health insurer. Overall, the mean±SD age of women was 30.1±4.7 years.
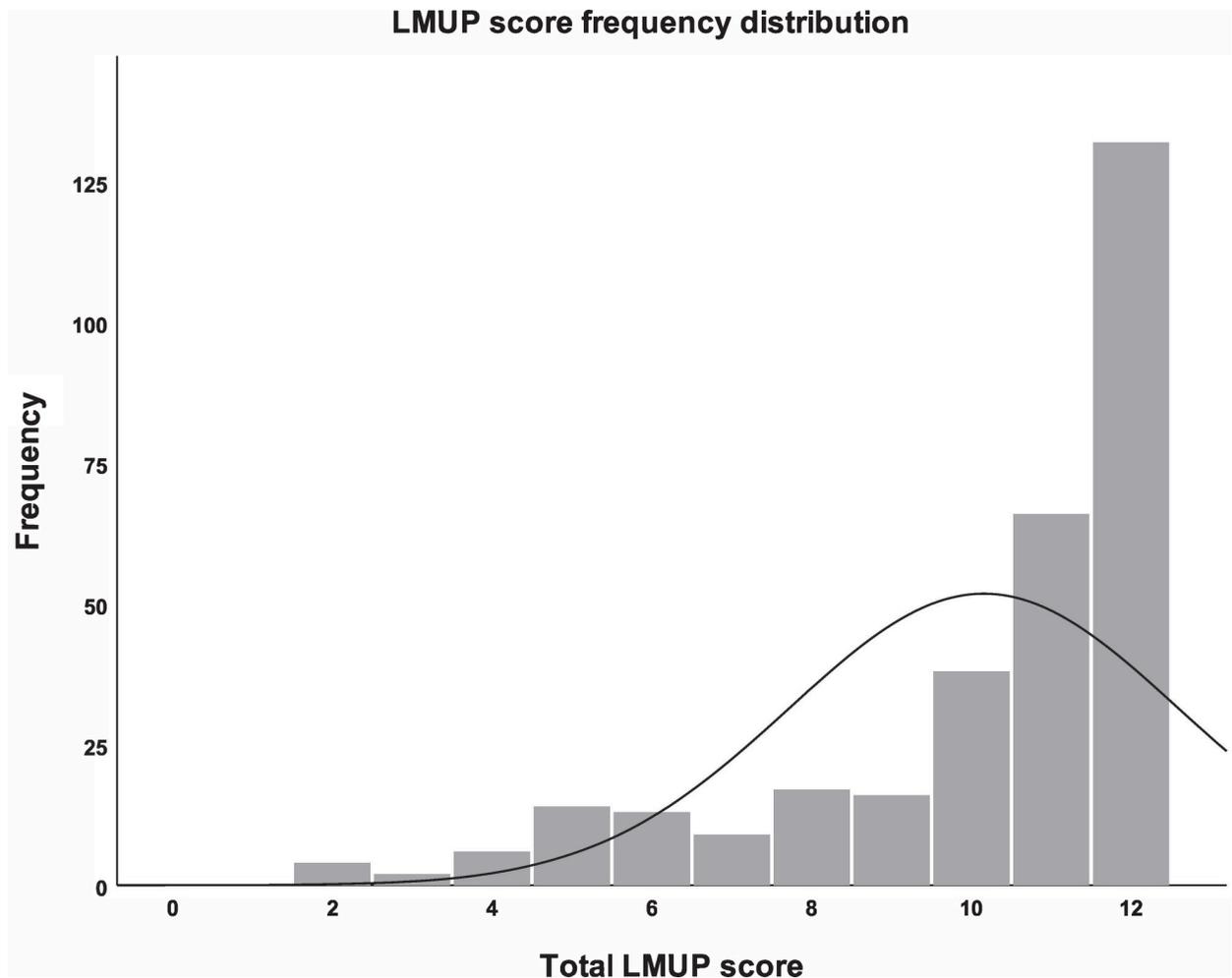
**Public maternity setting
Monash Health**

**Private maternity setting
Medibank Private Ltd**

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Eligible women invited
n=314
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Pregnant and non-pregnant women
aged 18-40 years with obstetrics
cover invited
n=4,870*
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Completed the LMUP
n=225
(71.7% completion rate)
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Pregnant and non-pregnant women
attempted the questionnaire
n=504
(10.3% completion rate)
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LMUP
test-retest
(twice)
n=131
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LMUP
non-retest
(once only)
n=94
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Eligible women identified as pregnant
completed the LMUP
n=92
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LMUP
non-retest
(once only)
n=92
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Total participated in the field test
n=317
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Fig 1. Recruitment and participation flow diagram. *56.8% of all invited women (n = 4,870) opened the original email invitation, 13.5% opened the questionnaire.

The majority (93.4%) of women were married (70.3%, n = 192) or de facto (23.1%, n = 63), had two children or fewer (94.1%, n = 270) and two-fifths were born overseas (42.5%, n = 116). The sample had high levels of post-secondary school education (83.5%, n = 228) and paid employment in the year before pregnancy (77.3%, n = 211) (Table 2). Overall, data were consistent with national averages (Table 2).

Demographic differences between the public and private cohorts included age (public 29.8 ±4.9 years vs private 31.2±4.0 years, p = 0.04), education (post-school qualification; public 79.2% vs private 98.4%, p<0.001) and employment in the year before pregnancy (employed; public 73.6% vs private 90.2%, p = 0.01). There were no differences in relationship status, number of children, place of birth and socio-economic status.

Fig 2. Distribution of LMUP scores.

The LMUP retest was completed by a subset of these women recruited through the public maternity service (n = 131). The only demographic difference among the retest and non-retest groups was whether they had a previous live birth (previous live birth; 59.5% retest vs 44.9% non-retest, p = 0.01), there were no other significant demographic differences between these groups (Table 2).

Acceptability and targeting

Cognitive testing of the LMUP did not reveal any concerns regarding the comprehension of the original LMUP items and no further changes were made. The lack of missing data in women's responses in the field test, triangulated with the findings from cognitive interviews, suggest that the items were acceptable to women.

Total LMUP scores ranged from 2 to 12. No woman received a score of 0 or 1 and therefore the score distribution was left-skewed (Fig 2). The median (IQR) score for all women was 11 (9, 12). Overall 74.4% of all women had a score of 10–12 (planned), 23.7% scored 4–9 (ambivalent) and 1.9% scored 0–3 (unplanned). In terms of item response options, the highest endorsements were "I/we were not using contraception" in item 1, "My partner and I agreed

that we would like me to be pregnant" in item 5, and "I wanted to have a baby" in item 4 (Table 1).

Reliability

The Cronbach's α was 0.81, the corrected item-total correlations were all >0.2 (item 1 0.42, item 2 0.66, item 3 0.78, item 4 0.64, item 5 0.65, item 6 0.53) and inter-item correlations were all positive.

The average number of interval days between test-retest was 17±5.7 days. The Cohen's Kappa was 0.92 and Percent Agreement was 0.99. The median (IQR) LMUP scores remained the same at test and retest, 11 (9, 12).

Validity

Principal component analysis confirmed the unidimensional structure of the scale, with one component (Eigenvalue, 3.4) and all six items loading onto that component (item 1 0.55 item 2 0.80 item 3 0.88, item 4 0.78, item 5 0.78, item 6 0.66). LMUP scores (median, IQR) were statistically significantly lower in women with ≥3 children (8, 6) compared to women with ≤2 children (11, 2) (p<0.01) and unmarried women who were not in a relationship (7.5, 7) compared to married/ de facto women (11, 2) (p<0.01).

Discussion

The aim of this study was to evaluate the suitability of the LMUP to determine pregnancy planning in a population of pregnant Australian women. Employing Classical Test Theory our findings show that the tool meets international standards for reliability and validity [41] and confirms this is an appropriate tool measuring pregnancy planning in an Australian antenatal population. Whilst the LMUP is becoming widely used internationally and applied in Australian studies [17, 18], this is the first time the psychometric properties have been evaluated in Australia. With the addition of iodine and vitamin D options in item six, the tool has been adapted and made appropriate for use in the Australian context.

Results of consumer testing through cognitive interviews indicated the tool was understandable and user friendly. These findings, coupled with the lack of missing data indicate the acceptability of the tool. High endorsement (frequent selection of a particular item response option e.g. 90.2% of women reporting they 'did not use contraception', Table 1) for the response options of some items was apparent and a limited range of LMUP scores were used. However, it is likely that this has occurred due to the study population including only women attending antenatal care and therefore missing representation of unplanned pregnancies that were terminated who may have selected different response options. This also resulted in negatively skewed data and high planned pregnancy rates in contrast to the original scale development, where the full range of scores were represented. Similar skewed findings were reflected in a recent Dutch antenatal LMUP validation study, with a high percentage of pregnancy planners (84.7% scoring 10–12) [22].

Pregnancy intention is complex and its measurement requires a nuanced and sensitive approach, offered by the LMUP tool [19]. Current international estimates of pregnancy planning measured in population surveys, such as the United States (US) Pregnancy Risk Assessment Monitoring System, are measured simplistically often asking one or two questions. These are sometimes asked up to 5 years after a woman's last birth, rather than for a current or recent pregnancy, as recommended by the LMUP [28, 42]. This approach includes many limitations including recall bias and potential overestimation of pregnancy intention [28]. A US consensus statement for improving preconception health and care recommend that the LMUP

be used as a patient reported outcome [4]. Our successful application of the LMUP both in a clinical maternity setting and online demonstrates how it can be implemented as a simple, quick, reliable tool providing a robust, comprehensive pregnancy intention measure in Australian settings, comparable to international research and outcome measures.

It is important to understand women's pregnancy planning and intentions, as different approaches to preconception care and engagement are likely needed for women across the spectrum of pregnancy planning [43]. Our study, for example, reflected high rates of pregnancy planning, with 74.4% of women scoring 10–12, classified as planned, 23.7% scoring 4–9 classified as ambivalent and 1.9% were classified as unplanned scoring 0–3, a finding consistent with a prior Australian and international studies [17, 22]. However, despite the large percentage of planned pregnancies overall, item six, which examines the health actions taken in preparation for pregnancy, showed that 28.4% of women took no preconception health actions and 18% only took one preconception health action. This highlights the potential missed opportunity and room for future engagement with women who are planning for pregnancy to improve preconception health by providing them with appropriate support and resources to improve their pregnancy outcomes.

In light of the prevalence of unplanned/ambivalent pregnancies, lack of awareness and poor uptake of preconception health actions, it is critical to consider pregnancy planning to better understand women's motivations, or lack thereof, for engaging in preconception health and behavior change. Implementation of the LMUP through maternity healthcare (e.g. by midwives or general practitioners) and other healthcare and research settings will provide vital information to raise awareness among policy makers of the breadth and complexity of the issues surrounding pregnancy planning and preconception health in Australia. It will allow researchers and policy makers to further elucidate the characteristics, determinants and social circumstances of women across the continuum of levels of pregnancy planning and engagement. Ongoing application of the LMUP in such a way can provide a population-level indicator for development, evaluation and monitoring of responsive policy, health promotion and primary care interventions to improve pregnancy outcomes. This will inform more sensitive and tailored engagement in improving this area of sexual and reproductive health across the lifespan from universal awareness raising and education to targeted approaches for improved preconception health and pregnancy outcomes.

Strengths and limitations

This is the first time the LMUP has been adapted and evaluated for use in the Australian context. A strength of this study is the psychometric testing process, including cognitive interviews and a high proportion (42.5%) of women born outside Australia from culturally and linguistically diverse backgrounds. As the current study validated the English version of the Australian LMUP, further studies should also explore whether the LMUP would need to be translated to other language versions. Given that approximately 70% of Australian women birth in public healthcare settings and one-third of Australian women birth in private hospitals, testing the LMUP in both public and private healthcare settings has enabled the study to capture a broad group of Australian women. Whilst the majority of women had post-school education and were from areas of low risk of disadvantage, 30% of women resided in areas at high risk of disadvantage, as defined by the SEIFA criteria [36]. Although the upper age limits for eligible women recruited through public and private settings differ slightly (40 vs 44 years of age respectively), only two women were aged over 40 years. Limitations include testing only in an antenatal population with pregnancies intending to continue to birth; further testing of the LMUP in women with pregnancies which they intend to terminate is warranted.

Conclusions

The LMUP is a valid and reliable measure of pregnancy planning/intention that can be applied in the Australian population. This study provides evidence of the suitability of the LMUP as a valid and reliable measure of pregnancy planning for Australian pregnant women. Implementation of this tool in maternity care and other healthcare and research settings will provide an accurate population-level estimate of pregnancy intention. Coupled with demographic and contextual information this will reveal the determinants of pregnancy planning/intention to inform improvements in engagement with women to enhance preconception health and reduce adverse birth and longer-term health outcomes. Public health and healthcare professionals such as midwives and general practitioners, researchers and policy makers all play a role in this effort. Importantly, implementation of the LMUP through these settings will enable monitoring and evaluation of the impact of preconception health policies and programs.

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References

1. Sedgh G, Singh S, Hussain R. Intended and unintended pregnancies worldwide in 2012 and recent trends. Stud Family Plann. 2014; 45(3):301–14. doi: 10.1111/j.1728-4465.2014.00393.x. PMC4727534. PMID: 25207494

2. Hall JA, Benton L, Copas A, Stephenson J. Pregnancy intention and pregnancy outcome: systematic review and meta-analysis. Matern Child Health J. 2017; 21(3):670–704. Epub 2017/01/18. doi: 10.1007/s10995-016-2237-0. PMID: 28093686.

3. Cheng TS, Loy SL, Cheung YB, Godfrey KM, Gluckman PD, Kwek K, et al. Demographic characteristics, health behaviors before and during pregnancy, and pregnancy and birth outcomes in mothers with different pregnancy planning status. Prev Sci. 2016; 17(8):960–9. Epub 2016/09/01. doi: 10.1007/s11121-016-0694-8. PMID: 27577198; PubMed Central PMCID: PMC5070636.

4. Frayne DJ, Verbiest S, Chelmow D, Clarke H, Dunlop A, Hosmer J, et al. Health care system measures to advance preconception wellness: Consensus recommendations of the Clinical Workgroup of the National Preconception Health and Health Care Initiative. Obstet Gynecol. 2016; 127(5):863–72. Epub 2016/04/08. doi: 10.1097/AOG.0000000000001379. PMID: 27054935.

5. Stephenson J, Heslehurst N, Hall J, Schoenaker DAJM, Hutchinson J, Cade JE, et al. Before the beginning: nutrition and lifestyle in the preconception period and its importance for future health. Lancet. 2018; 391(10132):1830–41. https://doi.org/10.1016/S0140-6736(18)30311-8 PMID: 29673873

6. Delissaint D, McKyer EL. A systematic review of factors utilized in preconception health behavior research. Health Educ Behav. 2011; 38(6):603–16. Epub 2011/04/23. doi: 10.1177/1090198110389709. PMID: 21511954.

7. Moos MK. Preconceptional health promotion: progress in changing a prevention paradigm. J Perinat Neonatal Nurs. 2004; 18(1):2–13. Epub 2004/03/19. PMID: 15027664.

8. Lang AY, Boyle JA, Fitzgerald GL, Teede H, Mazza D, Moran LJ, et al. Optimizing preconception health in women of reproductive age. Minerva Ginecol. 2018; 70(1):99–119. Epub 2017/09/13. doi: 10.23736/S0026-4784.17.04140-5. PMID: 28895680.

9. Hewitt B, England P, Baxter J, Shafer EF. Education and unintended pregnancies in Australia: Do differences in relationship status and age at birth explain the education gradient? Population Review. 2010; 49(1):36–52. https://doi.org/10.1353/prv.2010.0000

10. Tuomainen H, Cross-Bardell L, Bhoday M, Qureshi N, Kai J. Opportunities and challenges for enhancing preconception health in primary care: qualitative study with women from ethnically diverse communities. BMJ Open. 2013; 3(7). Epub 2013/07/26. doi: 10.1136/bmjopen-2013-002977. PMID: 23883884; PubMed Central PMCID: PMC3731794.

11. Rowe H, Holton S, Kirkman M, Bayly C, Jordan L, McNamee K, et al. Prevalence and distribution of unintended pregnancy: the Understanding Fertility Management in Australia National Survey. Aust N Z J Public Health. 2016; 40(2):104–9. Epub 2015/10/13. doi: 10.1111/1753-6405.12461. PMID: 26456762.

12. Australian Institute of Health and Welfare. Australia's mothers and babies 2016—in brief 2018 [cited 2018 09 September]. Available from: https://www.aihw.gov.au/reports/mothers-babies/australias-mothers-babies-2016-in-brief/data.

13. Children by Choice. Australian abortion law and practice 2019 [cited 2019 11 July]. Available from: https://www.childrenbychoice.org.au/factsandfigures/australianabortionlawandpractice.

14. Scheil W, Jolly K, Scott J, Catcheside B, Sage L, Kennare R. Pregnancy outcome in South Australia 2015. Adelaide: Pregnancy Outcome Unit, SA Health, Government of South Australia, 2017.

15. Michelson J. 'What women want when faced with an unplanned pregnancy' Sexual Health. 2007; 4 (4):297. https://doi.org/https://doi.org/10.1071/SHV4N4AB33

16. Kirkman M, Stubber C, Rowe H, Holton S, Bayly C, Jordan L, et al. Subjective meanings of 'unintended' pregnancy: interviews from understanding fertility management in contemporary Australia. Cult Health Sex. 2016:1–15. https://doi.org/10.1080/13691058.2016.1214287 PMID: 27684303

17. Rassi A, Wattimena J, Black K. Pregnancy intention in an urban Australian antenatal population. Aust N Z J Public Health. 2013; 37(6):568–73. Epub 2014/06/04. PMID: 24892156.

18. Cheney K, Sim KA, D'Souza M, Pelosi M, Black KI. Unintended pregnancy amongst an early pregnancy clinic cohort: Identifying opportunities for preventative health interventions. Aust N Z J Obstet Gynaecol. 2016; 56(4):426–31. Epub 2016/05/03. doi: 10.1111/ajo.12466. PMID: 27135463.

19. Barrett G, Smith SC, Wellings K. Conceptualisation, development, and evaluation of a measure of unplanned pregnancy. J Epidemiol Community Health. 2004; 58(5):426–33. Epub 2004/04/15. https://doi.org/10.1136/jech.2003.014787 PMID: 15082745; PubMed Central PMCID: PMC1732751.

20. Hall J, Barrett G, Mbwana N, Copas A, Malata A, Stephenson J. Understanding pregnancy planning in a low-income country setting: validation of the London measure of unplanned pregnancy in Malawi. BMC Pregnancy Childbirth. 2013; 13:200. Epub 2013/11/06. doi: 10.1186/1471-2393-13-200. PMID: 24188251; PubMed Central PMCID: PMC4228283.

21. Borges ALV, Barrett G, dos Santos OA, Nascimento NC, Cavalhieri FB, Fujimori E. Evaluation of the psychometric properties of the London Measure of Unplanned Pregnancy in Brazilian Portuguese. BMC Pregnancy Childbirth. 2016; 16(1):244. doi: 10.1186/s12884-016-1037-2. PMC4997749. PMID: 27557860

22. Goossens J, Verhaeghe S, Van Hecke A, Barrett G, Delbaere I, Beeckman D. Psychometric properties of the Dutch version of the London Measure of Unplanned Pregnancy in women with pregnancies ending in birth. PLoS One. 2018; 13(4):e0194033. https://doi.org/10.1371/journal.pone.0194033 PMID: 29668712

23. Rocca CH, Krishnan S, Barrett G, Wilson M. Measuring pregnancy planning: An assessment of the London Measure of Unplanned Pregnancy among urban, south Indian women. Demographic research. 2010; 23:293–334. doi: 10.4054/DemRes.2010.23.11. PMC3001625. PMID: 21170147

24. Morof D, Steinauer J, Haider S, Liu S, Darney P, Barrett G. Evaluation of the London Measure of Unplanned Pregnancy in a United States population of women. PLoS One. 2012; 7(4):e35381. doi: 10.1371/journal.pone.0035381. PMC3334919. PMID: 22536377

25. Roshanaei S, Shaghaghi A, Jafarabadi MA, Kousha A. Measuring unintended pregnancies in postpartum Iranian women: validation of the London Measure of Unplanned Pregnancy. East Mediterr Health J. 2015; 21(8):572–8. Epub 2015/10/09. PMID: 26446528.

26. Habib MA, Raynes-Greenow C, Nausheen S, Soofi SB, Sajid M, Bhutta ZA, et al. Prevalence and determinants of unintended pregnancies amongst women attending antenatal clinics in Pakistan. BMC Pregnancy Childbirth. 2017; 17(1):156-. doi: 10.1186/s12884-017-1339-z. PMID: 28558671.

27. Almaghaslah E, Rochat R, Farhat G. Validation of a pregnancy planning measure for Arabic-speaking women. PLoS One. 2017; 12(10):e0185433–e. doi: 10.1371/journal.pone.0185433. PMID: 29059191.

28. Hall JA, Barrett G, Copas A, Stephenson J. London Measure of Unplanned Pregnancy: Guidance for its use as an outcome measure. Patient Related Outcome Measures. 2017; 8:43–56. doi: 10.2147/PROM.S122420. PMC5388237. PMID: 28435343

29. National Health and Medical Research Council. Iodine supplementation during pregnancy and lactation —Literature Review 2010 [cited 2017 14 June]. Available from: https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new45_literature_review.pdf.

30. The Royal Australian College of General Practitioners. Guidelines for preventive activities in general practice. 9th edn East Melbourne: Vic: RACGP; 2016 [cited 2016 17 May]. Available from: http://www.racgp.org.au/your-practice/guidelines/redbook/.

31. Presser S, Couper MP, Lessler JT, Martin E, Martin J, Rothgeb JM, et al. Methods for testing and evaluating survey questions. Public Opin Q. 2004; 68(1):109–30.

32. Willis GB. Cognitive interviewing: a tool for improving questionnaire design. Thousand Oaks, CA: Sage; 2005.

33. Roscoe J. Fundamental Research Statistics for the Behavioural Sciences. 2nd edition ed. New York: Holt Rinehart & Winston; 1975.

34. Donner A, Eliasziw M. Sample size requirements for reliability studies. Stat Med. 1987; 6(4):441–8. https://doi.org/10.1002/sim.4780060404 PMID: 3629046

35. Streiner DL. Sample-Size Formulae for Parameter Estimation. Percept Motor Skills. 1994; 78(1):275–84. https://doi.org/10.2466/pms.1994.78.1.275

36. Australian Bureau of Statistics. 2033.0.55.001—Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2016 2018 [cited 2018 15 July]. Available from: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/2033.0.55.0012016?OpenDocument.

37. Lowenthal K, editor. An introduction to Pshychological Tests and Scales. 2 ed. London: Psychology Press; 2001.

38. Streiner D, Norman G, editors. Health measurement scales: a practical guide to their development and use. 3 ed. Oxford: Oxford University Press; 2003.

39. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33(1):159–74. Epub 1977/03/01. PMID: 843571

40. Australian Bureau of Statistics. 3301.0—Births, Australia, 2016 2017 [cited 2018 16 August]. Available from: https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3301.0Main+Features32016?OpenDocument.

41. Mokkink LB, Terwee CB, Patrick DL, Alonso J, Stratford PW, Knol DL, et al. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. J Clin Epidemiol. 2010; 63(7):737–45. Epub 2010/05/25. doi: 10.1016/j.jclinepi.2010.02.006. PMID: 20494804.

42. Centers for Disease Control and Prevention. PRAMS Questionnaires 2018 [cited 2018 16 August]. Available from: https://www.cdc.gov/prams/questionnaire.htm.

43. Barrett G, Shawe J, Howden B, Patel D, Ojukwu O, Pandya P, et al. Why do women invest in pre-pregnancy health and care? A qualitative investigation with women attending maternity services. BMC Pregnancy Childbirth. 2015; 15:236. Epub 2015/10/04. doi: 10.1186/s12884-015-0672-3. PMID: 26432278; PubMed Central PMCID: PMC4592566.