Obesity Research & Clinical Practice (2015) **9**, 499—506

ELSEVIER

ORIGINAL ARTICLE

The associations of anthropometric measurements with subsequent gestational diabetes in Aboriginal women

Maryam Sina*, **Wendy E. Hoy**, **Leonie Callaway**, **Zhiqiang Wang**

University of Queensland, Brisbane, Australia

Received 13 June 2014; received in revised form 13 November 2014; accepted 8 February 2015

KEYWORDS
Gestational diabetes;
Waist circumference;
Waist-to-height ratio;
BMI;
Aboriginal women

Summary
Problem: To evaluate the associations of different anthropometric measurements on earlier exam with subsequent gestational diabetes mellitus (GDM) in Aboriginal women.
Methods: This is a nested case—control study. Anthropometric measurements were conducted at baseline from 1992 to 1995 in a remote Aboriginal community. All subsequent pregnancies among the original participants were identified through review of hospital records of 20 years. Thirty-two women developed GDM and 99 women were hospitalised for pregnancy-related conditions other than GDM. The association between body mass index (BMI), weight, height, waist circumference, hip circumference, waist-to-hip ratio and waist-to-height ratio with subsequent GDM was examined.
Results: Our results showed an increased risk of GDM with increase in one standard deviation of BMI (OR = 2.0; 95% CI: 1.3, 3.1), weight (OR = 1.7; 95% CI: 1.1, 2.7), waist circumference (OR = 1.8; 95% CI: 1.1, 3.0) and waist-to-height ratio (OR = 2.3; 95% CI: 1.4, 3.9). High BMI (BMI $\geq$ 25 kg/m^2) was associated with subsequent GDM (OR = 2.8; 95% CI: 1.0, 7.8).
Conclusions: BMI and waist-to-height ratio are better predictors than other anthropometric indices of GDM in Aboriginal women. Given that these measures are associated with future GDM, interventions to reduce BMI, weight and waist circumference in young women need to be assessed for their potential to prevent GDM.

* Corresponding author: Tel.: +61 7 334 55 292; fax: +61 733465178.
E-mail address: m.sina@uq.edu.au (M. Sina).

http://dx.doi.org/10.1016/j.orcp.2015.02.005

Introduction

Insulin resistance, impaired glucose tolerance, gestational diabetes and Type 2 diabetes are important health problems for Australian Aboriginal people. While this is recognised, many of the risk factors for gestational diabetes mellitus (GDM) are assumed to be the same for Aboriginal and non-Aboriginal women. However, it is possible that risk factors for adverse pregnancy outcomes such as GDM may vary between Aboriginal and non-Aboriginal women, particularly given substantial differences in their body shapes [1—3]. In order to indicate the adiposity distribution, anthropometric measurements are simpler and less expensive to collect than adiposity imaging techniques [4].

Comparison of different anthropometric measurements of Aboriginal women with non-Aboriginal women have shown that Aboriginal women are significantly lighter than other women but have higher waist circumferences and waist-to-hip ratios [5]. These characteristics are associated with some of the most common chronic conditions such as hypertension and type 2 diabetes [6—9], which lead to almost a decade gap in life expectancy between Aboriginal and non-Aboriginal people [10].

Aboriginal women experience higher rates of pregnancy-related complications, such as GDM, than non-Aboriginal women [11]. Pregnancy-related conditions, such as GDM, are associated with adverse long-term outcomes, such as chronic hypertension and diabetes after pregnancy, and a higher risk of maternal and perinatal mortality in severe cases [12—14]. Prevalence of chronic conditions and complications during pregnancy are considerably higher in Aboriginal than non-Aboriginal populations. For instance, from 1999 to 2006, the rates of both GDM and type 2 diabetes increased simultaneously [15].

Campbell et al. assessed the associations of body mass index (BMI) and waist circumference with diabetes in pregnancy in Aboriginal women [16]. However, other anthropometric measurements, such as waist-to-height ratio, could predict GDM better than BMI and waist circumference [8,17]. The association between GDM and anthropometric measurements other than BMI and waist circumference have not been well reported in Aboriginal women and require further investigation.

This study aims to assess the associations of anthropometric measurements, such as waist and hip circumferences, waist-to-hip and waist-to-height ratios, in addition to BMI, measured up to 20 years prior to pregnancy, with GDM in Aboriginal women. The results of this study will assist health carers and health promoters to identify other obesity related risk factors than BMI, which may be better predictors of GDM in Aboriginal women.

Materials and methods

This is a nested case—control study. Two existing databases, including baseline and hospitalisation, were used in this study. Participants in this study were members of a remote Aboriginal community in the Northern Territory (NT), Australia aged 5+ years who participated in one or two community-wide health screenings performed in 1992—1996 and in 2004—2006. More than 80% of the adult people (age $\geq$ 20), except for menstruating females, and people who were hospitalised or on dialysis, participated in each screening [18]. Each adult participant gave written informed consent to the screening; while parents gave informed consent on behalf of the children.

The hospitalisation database included hospital records and emergency admissions of individuals within the public health system in the NT. The hospitalisation data were recorded according to the International Classification of Disease (ICD) 9 and ICD 10-AM codes (Table 1). All participants were followed up from the date of baseline examination to 31 May 2012, during which a diagnosis of GDM were identified through hospital records. Two databases, the baseline screening and the hospitalisation database, were merged using the patients' hospitalisation registration numbers. Women with the hospital admissions prior or during baseline were excluded, due to the potential impact of the pregnancy on their baseline anthropometric data. The protocol of the screening programmes was approved by the Tiwi Land Council and by the Ethics Committees of the NT Health Services of the Menzies School of Health Research and Territory Health Services and the Behavioural and Social Science Ethical Review Committee of the University of Queensland. This project was approved by the University of Queensland Ethics Committee.

Pregnancy and GDM ascertainment

From a total of 707 females who participated in the original study, 265 women had a record of pregnancy-related hospitalisations during the follow-up. Of them, 246 women had complete pregnancies (pregnancies without abortive outcomes) and 172 records of pregnancy-related hospital admissions after baseline (Fig. 1). Since the number of participants under the age of 15 at baseline was too small to calculate the *z*-scores of

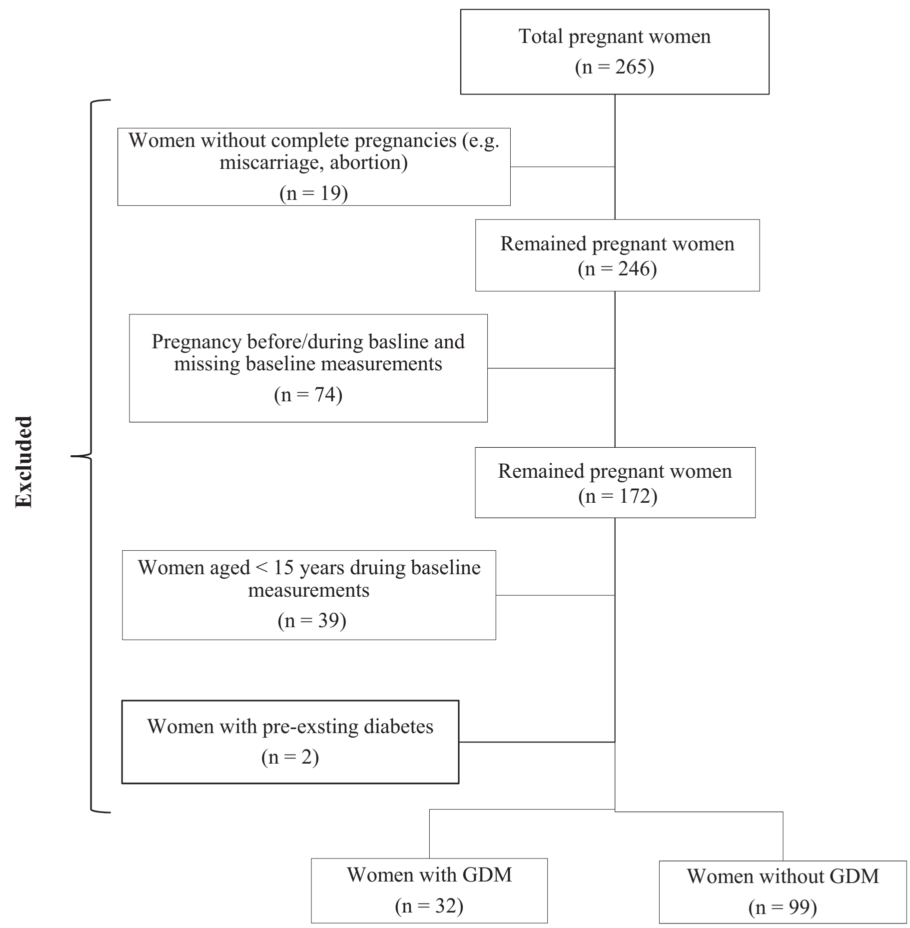

Figure 1 Flow chart including those who excluded and remained women with and without GDM.

anthropometric measurements, those younger than 15 years at baseline ($n = 39$) were excluded. Pre-existing diabetes was identified based on baseline fasting glucose level (≥7.0 mmol/l), glucose tolerance level (≥11.1 mmol/l) [19], and hospital records of diabetes (ICD codes as shown in Table 1) recorded prior to the identified pregnancies. Those with pre-existing diabetes were also excluded ($n = 2$).

Study groups

After reviewing the hospital records of the remaining 131 women, 32 had a record of GDM, and 99 women had other pregnancy-related ICD codes than GDM during our follow-up (Table 1). Only the first identified record of GDM and the first identified record of other pregnancy-related conditions after the baseline measurements were included in this study.

Anthropometric measurements

BMI was calculated as weight (kg) divided by height squared in metres. For the participants older than 18 years at baseline, high BMI was defined as BMI ≥ 25 kg/m^2. For participants younger than 18 years of age, high BMI was classified according to the standard cut-off values proposed by Cole et al. [20], as no BMI cut-off values have been developed

Table 1 ICD 9 and ICD 10-AM codes for hospital diagnoses.

Conditions of pregnancy	ICD-9 codes	ICD-10-AM codes
Pregnancies	630–647, 649–659	O09–O16, O20–O23, O25–O68, O70–O75, O80–O85
GDM	648	O24
Type 2 diabetes	250	E11

Table 2 Characteristics, % of *n* or mean (SD), in women with GDM (cases) and women without GDM (controls).

Characteristics	Women without GDM (controls) $n = 99$	Women with GDM (cases) $n = 32$	*P*-value
Baseline age, years, mean (SD)	21.9 (4.8)	23.7 (5.5)	0.07
BMI, kg/cm^2, mean (SD)	19.7 (5.1)	25.1 (7.6)	<0.001
High BMI, *n* (%)	16 (16.2)	14 (43.8)	0.002
Weight, kg, mean (SD)	52.1 (14.4)	63.7 (21.4)	<0.001
Height, cm, mean (SD)	158.2 (8.3)	157.0 (10.4)	0.48
Waist-circumference, cm, mean (SD)	81.3 (12.8)	90.3 (16.4)	0.003
Hips-circumference, cm, mean (SD)	91.3 (11.9)	98.3 (16.3)	0.01
Waist-to-hip ratio, mean (SD)	0.89 (0.08)	0.92 (0.05)	0.09
Waist-to-height ratio, mean (SD)	0.51 (0.08)	0.58 (0.12)	<0.001
Systolic blood pressure, Hg/mmol, mean (SD)[a]	105.2 (14.7)	114.0 (13.4)	0.004
Diastolic blood pressure, Hg/mmol, mean (SD)[a]	61.3 (11.1)	66.6 (10.7)	0.02
Albumin/creatinine ratio, (mean, SD)[a]	5.3 (16.0)	14.9 (23.9)	0.03
Smoking, *n* (%)	39 (39.4)	15 (48.4)	0.38
Drinkers, *n* (%)	14 (14.1)	6 (19.4)	0.48
Total number of pregnancies during study period, *n* (%)			
1	56 (56.6)	21 (65.6)	
>1	43 (43.4)	11 (34.4)	0.37

[a] Sample size varies because of the missing values for some variables (i.e. albumin creatinine ratio, systolic and diastolic blood pressure); however, sample size was the same for all of the anthropometric measurements ($n = 131$).

specifically for Aboriginal children. All the anthropometric measurements were measured by trained nurses and Aboriginal health workers. The procedures for performing anthropometric measurements of waist and hip circumferences have been described in detail elsewhere [21].

Data analysis

Means and standard deviations of baseline continuous variables, such as age, BMI, waist circumference and other anthropometric measurements were calculated for both case and control groups. Baseline categorical variables, such as high BMI, were calculated as percentages of numbers. In order to compare the differences in the anthropometric measurements between cases and controls, the differences in *z*-scores were calculated after adjusting for baseline age.

To evaluate the associations of anthropometric measurements of BMI, height, weight, waist circumference, hip circumference, waist-to-hip ratio and waist-to-height ratio as continuous variables with GDM, we used logistic regression to calculate odds ratios (ORs) corresponding to one standard-deviation (SD) increase in each of those anthropometric measurements. The association between high BMI and GDM was also assessed using the logistic regression method.

The associations between anthropometric indices and GDM were assessed after adjusting for age at baseline, baseline smoking and drinking status and maternal age. Since we did not have the number of parities before baseline, and increased age and BMI associated with increased parity and may confound the associations, the total number of pregnancies during the study period was adjusted for in addition to other confounding factors. All the tests and analyses were estimated with 95% confidence intervals (CI) and *P*-values of 0.05, using Stata 12.0 [22].

Results

Baseline demographic and anthropometric characteristics for cases and controls are presented in Table 2. Mean BMI was 25.1 kg/cm^2 (SD = 7.6) and 19.7 kg/cm^2 (SD = 5.1) in cases and controls, respectively. The mean of waist-to-height ratio was 0.58 (SD = 0.12) in cases and 0.51 (SD = 0.08) in controls.

The mean time difference between the baseline examination and hospital admissions was 4.4 years (SD = 3.6). The mean maternal age was 30.6 years (SD = 6.3) in cases and 25.4 years (SD = 5.0) in controls. Of the 99 women in the control group, 56 had one episode of pregnancy, with no records of previous parity, during the study period, and 43 (43.4%) had two or more episodes of pregnancies identified without GDM throughout the study period. Twenty-five of the cases were identified with GDM in their

Table 3 The differences of anthropometric measurements, according to corresponding to standard deviation score between women with GDM (cases) and women without GDM (controls).

	Crude			Adjusted for baseline age		
	Differences	95% CI	*P*-value	Differences	95% CI	*P*-value
BMI (kg/cm^2)	0.73	0.34, 1.11	<0.001	0.78	0.40, 1.17	<0.001
Weight (kg)	0.58	0.18, 0.97	0.004	0.64	0.24, 1.03	0.002
Height (cm)	−0.13	−0.48, 0.22	0.46	−0.08	−0.43, 0.27	0.64
Waist circumference (cm)	0.49	0.10, 0.88	0.013	0.50	0.11, 0.89	0.013
Hips-circumference (cm)	0.36	−0.03, 0.75	0.070	0.37	−0.03, 0.76	0.071
Waist-to-hip ratio	0.32	−0.05, 0.69	0.090	0.33	−0.04, 0.71	0.083
Waist-to-height ratio	0.58	0.22, 0.93	0.002	0.57	0.20, 0.93	0.003

first recorded pregnancy, and seven women had GDM recorded in the second or subsequent pregnancies in hospitalisation records (Table 2).

As shown in Table 3, the differences in the z-score of BMI, weight, waist circumference and waist-to-height ratio between cases and controls were significant. Cases had higher BMI than controls by 0.7 standard deviation (95% CI: 0.3, 1.1). The difference in BMI was greater than differences found in other measurements (Table 3). The magnitude of the differences did not considerably change after adjusting for baseline age.

Table 4 shows the associations of GDM with one standard deviation increase of anthropometric measurements. The risk of GDM increased per one standard deviation increase of all anthropometric measurements, except for height. Of them, BMI (OR = 2.0; 95% CI: 1.3, 3.1), weight (OR = 1.8; 95% CI: 1.2, 2.7), waist circumference (OR = 1.7; 95% CI: 1.1, 2.6) and waist-to-height ratio (OR = 2.0; 95% CI: 1.3, 3.1) were significantly associated with GDM. High BMI was also associated with GDM (OR = 4.0; 95% CI: 1.7, 9.7). After adjusting for baseline age, baseline drinking consumption, baseline smoking status, total number of pregnancies during study period and maternal age the ORs were 2.0 (95% CI: 1.3, 3.1), 1.7 (95% CI: 1.1, 2.7), 1.8 (95% CI: 1.1, 3.0) and 2.3 (95% CI: 1.4, 3.9) for BMI, weight, waist circumference and waist-to-height ratio, respectively (Table 4). The associations of anthropometric indices with GDM in order of the magnitude of OR estimates were waist-to-height ratio > BMI > waist circumference > weight (Table 4).

Discussion

Our results showed that all six assessed anthropometric indices, except for height, were positively associated with GDM, and could be used independently to predict GDM several years prior to pregnancy. We also found that BMI and waist-to-height ratio were better predictors of GDM than other anthropometric measurements. The odds of GDM increased 95%, 70%, 82% and 129% with one standard deviation increment in BMI, weight, waist circumference and waist-to-height ratio, respectively.

Our results showed that waist-to-height ratio was a better predictor of GDM compared to other anthropometric indices, which is consistent with similar studies on type 2 diabetes, conducted in other population groups [6—8]. Our study illustrated that women with GDM were more likely to have a higher ratio of waist circumference to height than those without GDM. This would suggest that visceral fat, which impacts most on waist circumference, is important in the development of both GDM and type 2 diabetes, since GDM is probably ''type 2 diabetes'' unmasked in pregnancy.

Our findings also suggested a negative association between height and GDM in women with larger waist circumference. Although the association between height and GDM was not statistically significant in our study, which could be due to our small sample size, positive association between waist-to-height ratio and GDM shows the importance of larger waist circumference in women with lower height values. Negative association between height and type 2 diabetes has also been reported by a number of studies undertaken in Aboriginal and non-Aboriginal population groups [9,23].

BMI and waist circumference have been reported as predictors for GDM and type 2 diabetes in a number of studies [16,24—27]. However, only one study has assessed the associations of waist circumference and BMI with diabetes in pregnancy in Aboriginal women [16]. The results of that study were consistent with ours, showing that waist circumference and BMI are associated with diabetes during subsequent pregnancies.

Table 4 The associations between anthropometric measurements and subsequent GDM.

	Crude			Adjusted[a]		
	OR[b]	95% CI	*P*-value	OR[b]	95% CI	*P*-value
BMI	2.04	1.34, 3.09	0.001	1.95	1.34, 3.09	0.006
High BMI (BMI $\geq$ 25 kg/m^2)	4.03	1.67, 9.73	0.002	2.82	1.02, 7.84	0.046
Weight	1.77	1.17, 2.67	0.007	1.70	1.08, 2.67	0.022
Height	0.84	0.54, 1.32	0.46	0.68	0.40, 1.17	0.17
Waist circumference	1.68	1.10, 2.56	0.016	1.82	1.12, 2.96	0.016
Hip circumference	1.46	0.97, 2.20	0.073	1.57	0.99, 2.48	0.056
Waist-to-hip ratio	1.49	0.94, 2.38	0.093	1.65	0.94, 2.91	0.082
Waist-to-height ratio	1.97	1.25, 3.10	0.003	2.29	1.35, 3.88	0.002

[a] The associations were adjusted for baseline and maternal age, total number of pregnancies during study period, smoking status and drinking consumption in baseline.

[b] The ORs of continuous anthropometric measures were calculated according to corresponding to standard-deviation increase.

However, our study is the first study to date to report on the associations of multiple anthropometric predictors, in addition to BMI and waist circumference, with GDM in Aboriginal women. Our result on the association between waist-to-hips ratio and GDM, although it was not statistically insignificant, was consistent with previous studies reported from Aboriginal and non-Aboriginal population groups [9,28].

There are limited studies assessing the associations of different obesity-related measurements (e.g. waist-to-height ratio and waist circumference) with type 2 diabetes/GDM. Aboriginal Australians are more likely to experience pregnancy related complications [29, 30], and they also tend to be obese in young adulthood [31]. Therefore, understanding the associations of different anthropometric measurements, taken prior to pregnancy, with GDM is potentially a useful method to identify high risk individuals [29]. Our findings could be beneficial for health carers identifying higher risk Aboriginal women according to their obesity-related characteristics (e.g. waist circumference, waist-to-height ratio and BMI), several years before pregnancy. In this study all participants were from a relatively homogenous Aboriginal community, which simplified the comparison of other contributing factors, e.g. socio-economic status, between the case and the control group.

One of the limitations of this study was its small sample size. A further limitation was the lack of information regarding parity, lipids, glycemia and self-reported nutrition status. It is possible that women who were identified as cases were of higher parity compared to women identified as controls. Since each pregnancy is associated with weight gain [32, 33], women identified as obese or with a higher waist circumference at baseline may have been of higher parity. However, our results showed significant associations between the anthropometric measurements and GDM even after adjusting for confounding factors including total number of pregnancies during study period and maternal age. This provides some support that parity has not confounded our findings.

In our study, most women (77.4%) who were identified with GDM had this identification during their first pregnancy after study enrolment. Therefore, we have no evidence that women diagnosed with GDM and categorised as cases were of higher parity. Nonetheless, in future studies, this is an important issue that should be considered and controlled for. The issues of whether baseline anthropometrics in Australian Aboriginal women are influenced by lifestyle factors in childhood and young adulthood, background genetics or pregnancy associated weight gain would be a valuable area for further research. We also recommend that health promoters implement programmes such as encouraging/educating Aboriginal women to have a healthier diet or undertake regular physical activities, to help them reduce their body size prior to pregnancy in order to prevent GDM.

Since women with GDM in this study were identified through hospital records, a small proportion of women with GDM might not have been hospitalised. Also those pregnant women with GDM might not have been correctly diagnosed and were misclassified as controls. This factor could have diluted the true associations between the anthropometric indices and GDM. It is possible that some women with undiagnosed pre-existing type 2 diabetes were miss-recorded as GDM cases. Nevertheless we have excluded those with incomplete pregnancies. Since those with pre-existing type 2 diabetes are at increased risk of poorer pregnancy outcomes and higher rate of pregnancy with abortive outcomes than those without type 2 diabetes [34, 35], those women with pre-existing type 2 diabetes may have been excluded due to their abortive outcomes in our study. It would be helpful to obtain data from multiple sources. GDM cases and those with pre-existing diabetes could have been identified through primary care data. There is also a possibility of human error in recording and measuring the anthropometric indices during baseline. Since this study was conducted in one remote community, the generalisability of our findings to other Aboriginal communities remains to be verified.

Conclusions

In conclusion, BMI, weight, waist circumference and waist-to-height ratio, several years prior to pregnancy, are associated with GDM in Australian Aboriginal women. The findings of this study have multiple clinical and public health implications. Ideally, pre-pregnancy interventions to reduce these anthropometric measures will be shown to prevent GDM and its associated outcomes, such as type 2 diabetes and cardiovascular disease.

Authors' contribution

The contributions of each author in this work are as follows: MS drafted the manuscript and performed data management and data analysis. WH and ZW obtained the data. MS, WH, ZW contributed to study design. ZW, WH and LC provided guidance for data analysis and interpretation. All authors critically reviewed, revised and approved the final draft of the manuscript.

Competing interests

The authors declare they have no competing interests.

Acknowledgements

This study was financially supported by grants from NHMRC: APP1025350, APP1042343 (ZW) and #511081 (WH). We especially thank the Aboriginal people who participated in this study. The baseline data were collected by the renal research team led by WH at the Menzies School of Health Research, Darwin, Australia. Shuqin Li at the Northern Territory Department of Health assisted in the interpretation of hospital data.

References

[1] Preventing infant deaths among Aboriginal and teenage women in South Australia. University of Adelaide; 2009. Available from: http://aboriginalhealth.flinders.edu.au/Newsletters/2010/Downloads/SHRP%20FINAL%20REPORT%20PART%20ONE%20July%202009v2.pdf
[2] Kondalsamy-Chennakesavan S, Hoy WE, Wang Z, Shaw J. Quantifying the excess risk of type 2 diabetes by body habitus measurements among Australian aborigines living in remote areas. Diabetes Care 2008;31(3):585—6.
[3] Potti S, Jain NJ, Mastrogiannis DS, Dandolu V. Obstetric outcomes in pregnant women with diabetes versus hypertensive disorders versus both. J Matern Fetal Neonatal Med 2012;25(4):385—8.
[4] WHO. Reliability of anthropometric measurements in the WHO Multicentre Growth Reference Study. Acta Paediatr Suppl 2006;450:38—46.
[5] Kondalsamy-Chennakesavan S, Hoy WE, Wang Z, Briganti E, Polkinghorne K, Chadban S, et al. Anthropometric measurements of Australian Aboriginal adults living in remote areas: comparison with nationally representative findings. Am J Hum Biol 2008;20(3):317—24.
[6] Perreault J, Dagenais G, Abdous B, Poirier P. Predictive value of waist-to-height ratio for the development of type 2 diabetes and impaired glucose tolerance: comparison with other anthropometric indices. Can J Diabetes 2009;33(3):283.
[7] Kuo RJ, Wu YH, Chen LK. Inability of waist-to-height ratio to predict new onset diabetes mellitus among older adults in Taiwan: a five-year observational cohort study. Arch Gerontol Geriatr 2011;53(1):e1—4.
[8] Jayawardana R, Ranasinghe P, Sheriff MHR, Matthews DR, Katulanda P. Waist to height ratio: a better anthropometric marker of diabetes and cardio-metabolic risks in South Asian adults. Diabetes Res Clin Pract 2013;99(3):292—9.
[9] Wang Z, Rowley K, Wang Z, Piers L, O'Dea K. Anthropometric indices and their relationship with diabetes, hypertension and dyslipidemia in Australian Aboriginal people and Torres Strait Islanders. Eur J Cardiovasc Prev Rehabil 2007;14(2):172—8.
[10] ABS. Life tables for Aboriginal and Torres Strait Islander Australians 2010—2012. Canberra: ABS; 2013. Contract No. 3302.0.55.003.
[11] Ishak M, Petocz P. Gestational diabetes among Aboriginal Australians: prevalence, time trend, and comparisons with non-Aboriginals Australians. Ethn Dis 2003;13:55—61.
[12] Falhammar H, Davis B, Bond D, Sinha K. Maternal and neonatal outcomes in the Torres Strait Islands with a sixfold increase in type 2 diabetes in pregnancy over six years. Australian and New Zealand. J Obstet Gynaecol 2010;50(2):120—6.
[13] Bellamy L, Casas JP, Hingorani AD, Williams D. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. Lancet 2009;373(9677):1773—9.
[14] Carpenter MW. Gestational diabetes, pregnancy hypertension, and late vascular disease. Diabetes Care 2007;30(Suppl. 2):S246—50.
[15] Chaubey S, Davis B, Sinha A. Diabetes in pregnancy. Indig Health 2011;13:34—7.
[16] Campbell SK, Lynch J, Esterman A, McDermott R. Prepregnancy predictors of diabetes in pregnancy among Aboriginal and Torres Strait Islander women in North Queensland, Australia. Matern Child Health J 2012;16(6):1284—92.

[17] Moses RG, Mackay MT. Gestational diabetes: is there a relationship between leg length and glucose tolerance? Diabetes Care 2004;27(5):1033—5.
[18] Wang Z, Hoy WE. Waist circumference, body mass index, hip circumference and waist-to-hip ratio as predictors of cardiovascular disease in Aboriginal people. Eur J Clin Nutr 2004;58(6):888—93.
[19] World Health Organization. Definition, diagnosis, and classification of diabetes mellitus and its complications: Part 1. Diagnosis and classification of diabetes mellitus. Geneva: Department of Noncommunicable Disease Surveillance: WHO; 1999.
[20] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. Br Med J 2000;320(7244):1240.
[21] Wang Z, Hoy W, McDonald S. Body mass index in aboriginal Australians in remote communities. Aust N Z J Public Health 2000;24(6):570—5.
[22] StataCorp. Stata statistical software: release 12. College Station, TX: Stata Corporation; 2011.
[23] Ranasinghe P, Jayawardana MA, Constantine GR, Sheriff MHR, Matthews DR, Katulanda P. Patterns and correlates of adult height in Sri Lanka. Econ Hum Biol 2011;9(1):23—9.
[24] Ehrenthal DB, Jurkovitz C, Hoffman M, Jiang XZ, Weintraub WS. Prepregnancy body mass index as an independent risk factor for pregnancy-induced hypertension. J Women's Health 2011;20(1):67—72.
[25] Heude B, Thiebaugeorges O, Goua V, Forhan A, Kaminski M, Foliguet B, et al. Pre-pregnancy body mass index and weight gain during pregnancy: relations with gestational diabetes and hypertension, and birth outcomes. Matern Child Health J 2012;16(2):355—63.
[26] Yogev Y, Visser G. Obesity, gestational diabetes and pregnancy outcome. Semin Fetal Neonatal Med 2009;14:77—84.
[27] Dodd JM, Grivell RM, Nguyen AM, Chan A, Robinson JS. Maternal and perinatal health outcomes by body mass index category. Aust N Z J Obstet Gynaecol 2011;51(2):136—40.
[28] Bo S, Menato G, Signorile A, Bardelli C, Lezo A, Gallo ML, et al. Obesity or diabetes: what is worse for the mother and for the baby? Diabetes Metab 2003;29(2):175—8.
[29 Australian Indigenous Health Infonet. Birth and pregnancy outcome. Overview of Australian indigenous health status 2011; 2011. Available from: http://www.healthinfonet.ecu.edu.au/health-facts/overviews/births-and-pregnancy-outcome [01.12.13].
[30] Women's Health. The new national agenda. Australian Women's Health Network position paper. Canberra: Australian Women's Health Network; 2008.
[31] Sanigorski AM, Bell AC, Kremer PJ, Swinburn BA. High childhood obesity in an Australian population. Obesity 2007;15(8):1908—12.
[32] Luoto R, Männistö S, Raitanen J. Ten-year change in the association between obesity and parity: results from the National FINRISK Population Study. Gend Med 2011;8(6):399—406.
[33] Chiba T, Ebina S, Kashiwakura I. Influence of maternal body mass index on gestational weight gain and birth weight: a comparison of parity. Exp Ther Med 2013;6(2):293—8.
[34] Lapolla A, Dalfra MG, Di Cianni G, Bonomo M, Parretti E, Mello G. A multicenter Italian study on pregnancy outcome in women with diabetes. Nutr Metab Cardiovasc Dis 2008;18(4):291—7.
[35] Tennant PW, Glinianaia SV, Bilous RW, Rankin J, Bell R. Pre-existing diabetes, maternal glycated haemoglobin, and the risks of fetal and infant death: a population-based study. Diabetologia 2014;57(2):285—94.