

Association between maternal adiposity and growth of fetal fractional limb volume

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Abstract

Objective: Maternal obesity influences birth weight and newborn adiposity. Recently, fetal fractional limb volume has been introduced as a useful parameter for the proxy of fetal adiposity. It is known that fetal fat accretion accelerates in the third trimester of gestation, however, the association between maternal adiposity and the growth of fetal fractional limb volume has not been examined. This study aimed to define the effect of maternal pre-pregnancy BMI on the growth of fractional limb volume.

Design: Exploratory observational study

Method: Women with singleton pregnancies were enrolled between July 2017 and June 2020. Exclusion criteria were multiple gestations, uterine anomalies, chronic hypertension, pregestational diabetes, smoking, congenital malformations, and chromosomal abnormalities. Fetal fractional limb volume was assessed between 20 and 40 weeks' gestation. Fractional limb volume was measured as cylindrical limb volume based on 50% of the total diaphysis length to eliminate the proximal or distal end of the diaphysis, where the soft tissue boundaries are poorly visualized. The measured fractional limb volume at each gestational week were converted to z-scores based on a previous report. Multiple linear regression was used to quantify the association between pre-pregnancy BMI and fractional arm volume and thigh volume, with adjustment for potential confounding variables including maternal age, parity, gestational weight gain and infant sex.

Results: Ultrasound scans of 455 fractional arm volume and thigh volume were obtained from 255 mothers. Fractional arm and thigh volume increased linearly with respect to gestational age until the second trimester of gestation; it then increased exponentially in the third trimester. Maternal pre-pregnancy BMI was significantly correlated with z-scores of fractional arm volume and thigh volume across gestation. The post-hoc analysis showed the correlation was significant between 28 - 40 weeks for fractional arm volume, and 20 - 27 weeks for fractional thigh volume.

Conclusions: Maternal obesity influences the growth pattern of fetal fractional limb volume. Fractional arm volume is associated with maternal adiposity in the third trimester of gestation, which could originate from increased fetal adiposity in the arm. Fractional arm volume may potentially provide a useful surrogate marker of fetal nutritional status in late gestation.

Objectives

- Maternal obesity influences birth weight and newborn adiposity.
- Recently, fetal fractional limb volume has been introduced as a useful parameter for the proxy of fetal adiposity.
- It is known that fetal fat accretion accelerates in the third trimester of gestation, however, the association between maternal adiposity and the growth of fetal fractional limb volume has not been examined.
- This study aimed to define the effect of maternal pre-pregnancy BMI on the growth of fractional limb volume.

Study Design

- Women with singleton pregnancies were enrolled between July 2017 and June 2020.
- Exclusion criteria: multiple gestations, uterine anomalies, chronic hypertension, pregestational diabetes, smoking, congenital malformations, and chromosomal abnormalities.
- Fetal fractional limb volume was assessed between 20 and 40 weeks' gestation.
- Fractional limb volume was measured as cylindrical limb volume based on 50% of the total diaphysis length to eliminate the proximal or distal end of the diaphysis, where the soft tissue boundaries are poorly visualized (Figure 1).
- The measured fractional limb volume at each gestational week were converted to z-scores based on a previous report.
- Multiple linear regression was used to quantify the association between pre-pregnancy BMI and fractional arm volume and thigh volume, with adjustment for potential confounding variables including maternal age, parity, gestational weight gain and infant sex.

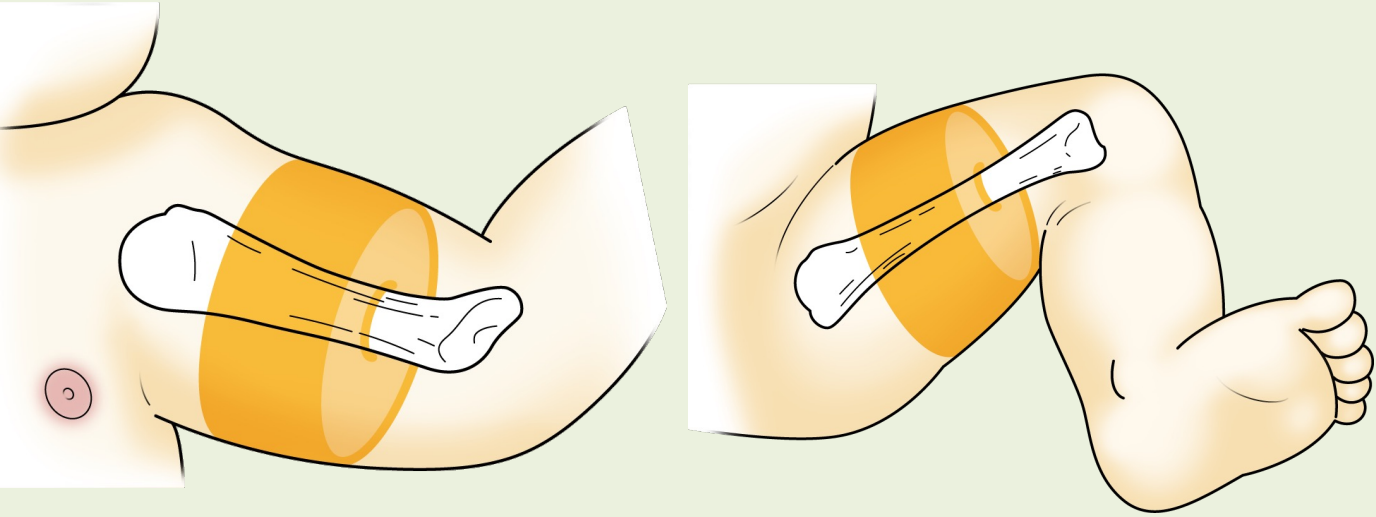
Results

Table 1. Maternal and neonatal socio-demographic and clinical characteristics

Characteristics (n = 255)	
Age, years	32.5 ± 5.6
Pre-pregnancy BMI, kg/m ²	21.7 ± 3.2
Primiparous	134 (52%)
Gestational weight gain	9.1 ± 4.4
Hypertensive disorders in pregnancy	5 (2.0%)
Gestational diabetes	48 (18%)
Birth weight	2813 ± 551
Small for gestational age	19 (7.4%)
Large for gestational age	22 (8.6%)
Infant sex (female)	117 (49%)

Data are presented as mean ± SD or N (%).

Figure 1. Fractional limb volume measures



- Cylindrical Limb sub-volume based on 50% of total diaphysis length.
- Eliminates the need for tracing soft tissue borders near the ends of the bone shaft, where acoustic shadowing is more likely to be encountered.

Figure 2. Scatterplots of prepregnancy BMI and Fractional limb volume (z score)

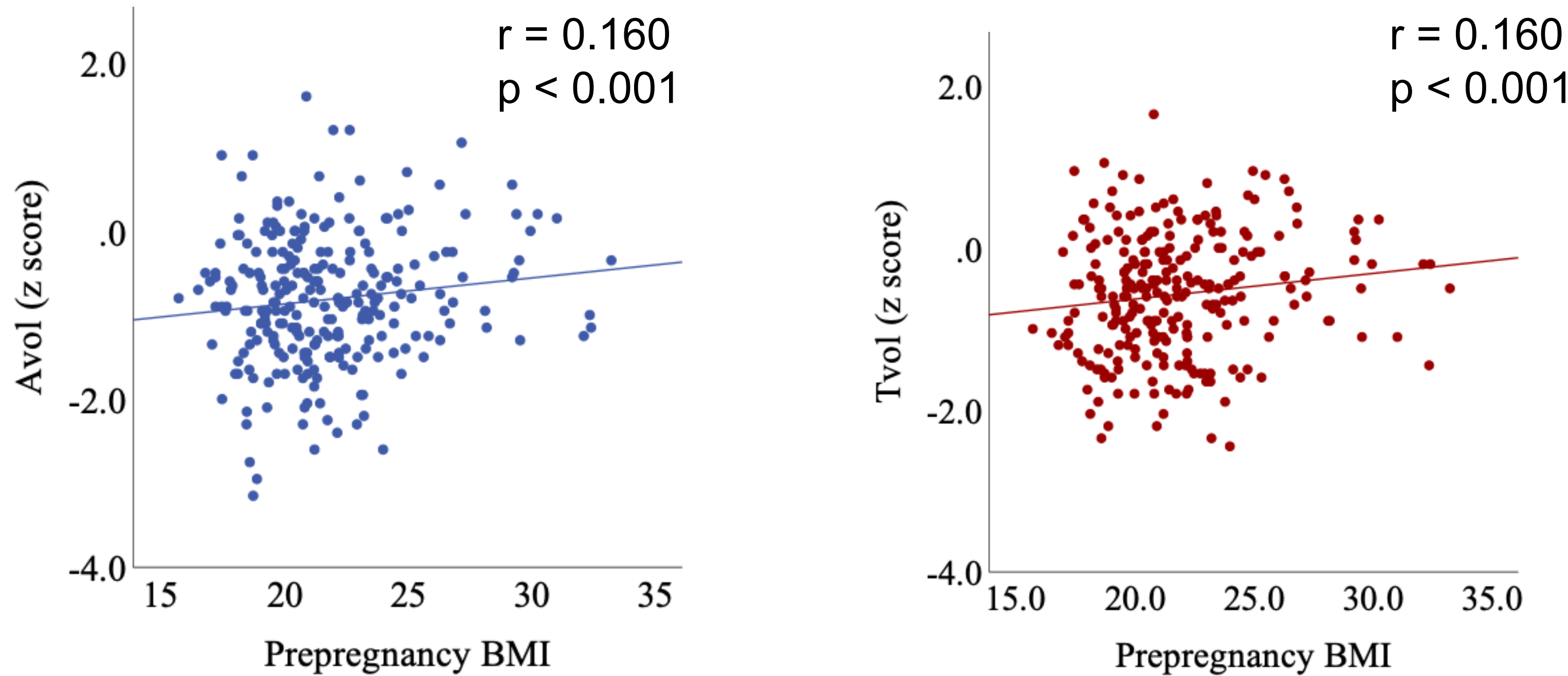


Table 2. Association between pre-pregnancy BMI and fetal fractional limb volume and conventional fetal parameters stratified by gestational age at ultrasound scan.

	20-27 weeks (n = 165)		28-33 weeks (n = 165)		34-40 weeks (n = 125)	
	r	p	r	p	r	p
AVol	0.102	0.192	0.163	0.037	0.245	0.006
TVol	0.197	0.011	0.145	0.063	0.162	0.071
AC	0.152	0.052	0.216	0.005	-0.136	0.130
EFW	0.127	0.103	0.227	0.003	-0.124	0.167

Conclusion

- Maternal obesity influences the growth pattern of fetal fractional limb volume.
- Fractional arm volume is associated with maternal adiposity in the third trimester of gestation, which could originate from increased fetal adiposity in the arm.
- Fractional arm volume may potentially provide a useful surrogate marker of fetal nutritional status in late gestation.

References

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