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Symphysis-fundal height curve in the diagnosis of fetal growth deviations

Curva de altura uterina por idade gestacional e diagnóstico de desvios do crescimento fetal

ABSTRACT

OBJECTIVE: To validate a new symphysis-fundal curve for screening fetal growth deviations and to compare its performance with the standard curve adopted by the Brazilian Ministry of Health.

METHODS: Observational study including a total of 753 low-risk pregnant women with gestational age above 27 weeks between March to October 2006 in the city of João Pessoa, Northeastern Brazil. Symphysis-fundal was measured using a standard technique recommended by the Brazilian Ministry of Health. Estimated fetal weight assessed through ultrasound using the Brazilian fetal weight chart for gestational age was the gold standard. A subsample of 122 women with neonatal weight measurements was taken up to seven days after estimated fetal weight measurements and symphysis-fundal classification was compared with Lubchenco growth reference curve as gold standard. Sensitivity, specificity, positive and negative predictive values were calculated. The McNemar χ^2 test was used for comparing sensitivity of both symphysis-fundal curves studied.

RESULTS: The sensitivity of the new curve for detecting small for gestational age fetuses was 51.6% while that of the Brazilian Ministry of Health reference curve was significantly lower (12.5%). In the subsample using neonatal weight as gold standard, the sensitivity of the new reference curve was 85.7% while that of the Brazilian Ministry of Health was 42.9% for detecting small for gestational age.

CONCLUSIONS: The diagnostic performance of the new curve for detecting small for gestational age fetuses was significantly higher than that of the Brazilian Ministry of Health reference curve.

DESCRIPTORS: Embryonic and Fetal Development. Uterus, growth & development. Gestational Age. Ultrasonography, Prenatal. Prenatal Diagnosis. Validation Studie.

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RESUMO

OBJETIVO: Validar curva de referência de altura uterina por idade gestacional para o rastreamento de desvios do crescimento fetal e comparar sua performance com a curva-padrão adotada pelo Ministério da Saúde do Brasil.

MÉTODOS: Estudo observacional que envolveu 753 gestantes de baixo risco de João Pessoa, PB, entre março e outubro de 2006, com idade gestacional acima de 27 semanas. A altura uterina foi medida de acordo com técnica preconizada pelo Ministério da Saúde. O padrão-ouro foi o peso fetal, estimado pelo ultrassom com base na curva de referência brasileira por idade gestacional. Uma subamostra de 122 casos com pesos neonatais obtidos até sete dias depois da estimativa do peso fetal, a classificação da altura uterina foi comparada com a curva de Lubchenco como padrão-ouro. A sensibilidade, a especificidade e os valores preditivos positivo e negativo foram calculados. Para comparar o desempenho da sensibilidade entre ambas as curvas de altura uterina, utilizou-se o teste χ^2 de McNemar.

RESULTADOS: A sensibilidade da nova curva para a detecção de fetos pequenos para a idade gestacional foi de 51,6%, enquanto a da curva do padrão-ouro foi significativamente menor (12,5%). Na subamostra que teve o peso neonatal como padrão-ouro, a sensibilidade da nova curva de referência foi de 85,7%, enquanto a do Ministério da Saúde exibiu 42,9% de sensibilidade para a detecção de fetos pequenos para a idade gestacional.

CONCLUSÕES: A capacidade diagnóstica da nova curva de referência para detectar fetos pequenos para a idade gestacional foi significativamente melhor do que a da curva recomendada pelo Ministério da Saúde.

DESCRIPTORIOS: Desenvolvimento Embrionário e Fetal. Útero, crescimento & desenvolvimento. Idade Gestacional. Ultrassonografia Pré-Natal. Diagnóstico Pré-Natal. Estudos de Validação.

INTRODUCTION

Serial measurement of symphysis-fundal height (SFH) during pregnancy is a major clinical tool to evaluate fetal growth as well as to identify other pregnancy complications.^a It is an easy-to-use low-cost tool, although it has not been widely confirmed as a reliable measurement in the prenatal care routine. Belizan et al⁴ showed these serial measurements greatly improve the predictive capacity of detecting fetal growth abnormalities. The Brazilian Ministry of Health (BMoH) recommends the use of a standard SFH curve developed by Fescina et al.⁹ Normal uterine growth is within the 10th and the 90th percentiles.^b However, studies have reported different SFH patterns for Brazilian populations,^{10,18,21} and these differences could be explained not only by specific characteristics of ethnic groups but also by other factors such as different measurement techniques, risk level, socioeconomic and nutritional conditions, gestational age estimates and number of examiners.

The relationship between SFH and gestational age can provide clinical indications of fetal growth deviations. However, studies have found inconsistent performance results.^{4,9,11,19,21} Despite the lack of a single reliable method to identify fetal growth deviations, combined clinical and ultrasound methods improve diagnosis.^{5,6,15,18} As for the diagnosis of fetal growth restriction, newborn's weight is only a final measurement which does not allow any kind of intervention to manage fetal weight gain.^{5,6} On the other hand, fetal weight estimates using ultrasound provides data that enable to diagnose conditions that may be impairing fetal growth.^{5,6} However, the SFH curve is a non-invasive, easy-to-use, low-cost tool that may be used to support important clinical decisions for either diagnostic or therapeutic interventions in developing countries where access to sophisticated technological resources for the assessment of fetal growth is not

^a Ministério da Saúde. Pré-natal e puerpério: atenção qualificada e humanizada: manual Técnico. 2.ed. Brasília, DF; 2006.

^b National Collaborating Center for Women's and Children's Health. Antenatal care: routine care for the healthy pregnant woman. Clinical Guideline. 2.ed. London: RCOG Press; 2009 [cited 2009 Sep 9]. Available from: <http://www.nice.org.uk/nicemedia/pdf/CG62FullGuidelineCorrectedJune2008July2009.pdf>

always available. Although SFH curves are usually used to screen fetal growth restriction, there are concerns about their performance.

Freire et al¹⁰ have demonstrated that the UH growth curve developed with low risk pregnant women from Joao Pessoa (Northeastern Brazil), differs significantly from that adopted by the BMoH⁹ as the standard for the Brazilian population.

Differences between both curves, the one from Freire et al¹⁰ and that from Fescina et al⁹ used by the BMoH, raise the hypothesis that they perform differently when identifying normal fetal growth and any deviations. Therefore, since one of the main applications of SFH measurements in prenatal care is for screening fetal growth deviations,^a the standard curve may not be effective enough for this purpose, over or under diagnosing those conditions because it is based in a sample of women with a pattern of fetal growth different from that of the Brazilian population. The objective of the present study was to validate the SFH growth curve as a standard method for the screening of fetal growth deviations and to compare its performance with the pattern curve adopted by the Brazilian Ministry of Health.

METHODS

The validation of a SFH reference curve for gestational age was based on a curve developed by Freire et al.¹⁰ The present study was carried out in a university hospital and a public maternity hospital in the city of João Pessoa, Northeastern Brazil, from March to October 2006. These hospitals were selected as they are reference centers of prenatal care in the public health service and they have higher demand of pregnant women. Eligibility of pregnant women was assessed in the ultrasound department of these hospitals. The sample size was calculated based on an estimated prevalence of 12% intra-uterine growth restriction in this population.^a An 80% sensitivity for SFH measurements was assumed for detection of actual fetal growth restriction in the sample, with a sampling error of 9.2% and type I error of 0.05. The estimated sample size was 750 pregnant women. A sample of 753 pregnant women was selected according to free demand for each prenatal service.

The inclusion criteria included gestational age above 26 weeks, with a known last menstrual period or confirmed by ultrasound during the first half of pregnancy. Women who were pregnant with twins, fetal death or any fetal malformations that prevented the assessment of fetal weight and the amniotic fluid index by ultrasound were excluded. The following variables were studied: SFH, gestational age, ultrasound-derived estimated fetal weight (EFW), and fetal growth deviation (categorized by gestational age in small – lower than the 10th percentile; large – higher than the 90th percentile; and adequate

– between the 10th and the 90th percentiles). Data was also collected for the following control variables: age; body mass index (BMI, classified by reference values for each gestational age according to Atalah et al¹ as recommended by the BMoH); ethnic group/skin color; number of pregnancies; parity; previous caesarean sections; previous abortions and smoking habits.

SFH was measured with a flexible inelastic measuring tape from the pubic symphysis to the uterine fundus after correction of uterine dextrorotation, following the standard technique as recommended by the BMoH.^{10,a} Fetal weight was estimated by ultrasound using Hadlock et al formula¹³ as described elsewhere.⁵ The gold standard for classifying EFW was adapted from the curve developed by Cecatti et al⁵ with normal EFW percentiles established by ultrasound according to gestational age in a Brazilian population using third degree polynomial adjustments. We opted for this method due to high linear correlation previously found between EFW and neonatal weight.⁶

SFH measurements were taken in pregnant women attending prenatal care visits for routine ultrasound examination. Data was recorded in standard forms by the examiner. Ultrasound scans were performed with GE[®] Voluson 730 PRO and GE[®] Logic 500 equipment, both with multifrequency (2.5–5.0 MHz) convex probes.

For statistical analysis, SFH and EFW values for each pregnant woman in the study were plotted on their related charts as a function of gestational age and were compared to related standards. To validate Freire et al SFH growth curve,¹⁰ sensitivity, specificity, positive and negative predictive values were calculated for screening fetal growth deviation. The gold standard for diagnosing SGA and large for gestational age (LGA) fetuses was the classification of fetal weight using ultrasound-derived EFW reference curve developed by Cecatti et al.⁵ The same procedure was then performed with the BMoH SFH curve. For the comparison of sensitivity, the McNemar's χ^2 test was used for non-independent samples with Yates' correction.

In a subsample of 122 women SFH measurements were taken up to seven days before delivery. Additionally, SFH classification was compared with neonatal weight classification based on Lubchenco et al's curve¹⁷ as the gold standard. SFH sensitivity for the diagnosis of fetal growth deviations was also compared with that of the BMoH standard SFH curve. A level of significance of 5% was set. For statistic analysis EpiInfo 2000 and Excel[™] software were used.

The study protocol was approved by the Institutional Review Board of the Centro de Ciências da Saúde da Universidade Federal da Paraíba (3/23/2005) and the Instituto e Maternidade Cândida Vargas (3/11/2005).

RESULTS

The age of the 753 women studied ranged between 13 and 45 years old, with mean age of 26.5. The predominant ethnic group/skin color was white (46.6%); BMI ranged between 18.9 kg/m² and 37.8 kg/m² with mean BMI of 27 kg/m². Most of them did not smoke (97.6%). Table 1 shows that 47.5% were primigravida, 50% had never had a delivery and 17.2% had previous cesarean sections. Gestational age ranged between 29 and 41 weeks, and most were over 32 weeks of pregnancy.

Figure 1 shows the distribution of SFH measurements against the 10th percentile and the 90th percentile in Freire et al SFH curve.¹⁰ The majority of cases were considered adequate (64.3%) and 10.5% were SGA. Compared to Cecatti et al curve,⁵ the proportion of adequate growth increased (70.1%) while the proportion of SGA (8.5%) and LGA (21.4%) decreased.

The sensitivity of SFH curve for the diagnosis of SGA and LGA, using the ultrasound-derived EFW curve as gold standard, is outlined in Table 2. Table 3 shows the sensitivity of SFH curve for the diagnosis of SGA and LGA using the neonatal weight curve as gold standard. The sensitivity of Freire et al¹¹ curve for detecting SGA was 51.6% while that of the BMoH curve was only 12.5%, a statistically significant difference. When using actual neonatal weight, the sensitivity of the SFH curve was also higher for detecting SGA (85.7%) than that of the BMoH curve (42.9%).

DISCUSSION

This study validated the SFH curve developed by Freire et al¹⁰ and compared its performance with that of the BMoH curve^a in a population of pregnant women under conditions similar to those seen in public health facilities in Brazil. This sample characteristic may be attributed to BMI distribution in the population as a significant association between BMI and SFH measurement was seen (data not shown). Almost half of pregnant women with fetal growth lying above the 90th percentile was classified as overweight or obese,^a higher proportion than those below the 90th percentile in the SFH curve (23.1%) ($p < 0.0001$; data not shown). The BMI in the sample seems to reflect the behavior of ultrasound-derived EFW, which showed 8.5% of SGA and 21.4% of LGA. BMI was also significantly associated with EFW ($p < 0.001$; data not shown) as the proportion of overweight or obese pregnant women was significantly higher in the LGA (41.0%) than in the non-LGA group (25.7%). This may explain the high prevalence of LGA in the sample, as well as reflect the so-called “obesity epidemics” as currently described in Western societies.

In general, studies on fetal growth curves among Brazilian women¹⁹ use Hadlock et al curve¹³ as a

Table 1. Percentage distribution of pregnant women according to demographic and obstetric characteristics. João Pessoa, Northeastern Brazil, 2006.

Variable	n	%
Age (years)		
14–19	105	13.9
20–24	188	25.0
25–29	217	28.8
≥30	243	32.3
Ethnic group/skin color		
White	351	46.6
Mixed	341	45.3
Black	61	8.1
Body mass index		
Low weight	142	18.9
Adequate	390	51.8
Overweight	162	21.5
Obesity	59	7.8
Smoking		
Yes	18	2.4
No	735	97.6
Number of pregnancies		
1	360	47.8
2	229	30.4
3	109	14.5
≥4	55	7.3
Parity		
0	380	50.5
1	252	33.5
2	96	12.7
≥3	25	3.3
Previous caesarean sections		
Yes	145	19.3
No	608	80.7
Previous abortions		
Yes	86	11.4
No	667	88.6
Gestational age		
27–31	150	19.9
32–36	282	37.5
≥37	321	42.6
Total	753	100.0

reference. However, a fetal growth curve created from a specific Brazilian population would be more appropriate, so the present study used the EFW curve, which was developed based on a sample of Brazilian women^{5,6} to assess SFH for diagnosing SGA and LGA. There is a wide variation in the performance of SFH measurements as a method for screening fetal growth

Table 2. Performance of the symphysis-fundal height curve for the diagnosis of small for gestational age and large for gestational age (n=753) with the ultrasound-derived estimated fetal weight curve as gold standard and comparison with the symphysis-fundal height curve of the Brazilian Ministry of Health. João Pessoa, Northeastern Brazil, 2006.

Symphysis-fundal height	Ultrasound-derived estimated fetal weight			
	SGA		No-SGA	
SGA	33		46	
No-SGA	31		643	
Total	64		689	
	LGA		No-LGA	
LGA	91		99	
No-LGA	70		493	
Total	161		592	
Performance	SGA		LGA	
	SFH curve(%)	BMoH curve (%)	SFH curve (%)	BMoH curve (%)
Sensitivity	51.6 *	12.5 *	56.5	84.5
Specificity	93.3	98.4	84.3	52.9
Positive predictive value	41.8	42.1	47.9	32.8
Negative predictive value	95.4	92.4	87.6	92.6

(*) significant difference; McNemar's χ^2 with Yates' correction = 23.04; $p < 0.0001$

SGA: small gestational age; LGA: large gestational age; SFH: symphysis-fundal height; BMoH: Brazilian Ministry of Health

deviation, especially when detecting SGA fetuses. It seems that the variation in the diagnostic performance between SFH reference curves is influenced not only by sociodemographic characteristics, but also by different methods used in the studies, the standardization of the technique used to measure SFH, the population under study (high- and low-risk pregnant women), and criteria used to define fetal growth restriction.

Belizan et al⁴ first reported 86% sensitivity and 90% specificity with 10% false positives, and concluded

that SFH measurements can be used in the prenatal care to screen for fetal growth restrictions. Ghate et al¹² assessed the performance of the SFH curve in predicting low-weight newborns and they found 87.5% sensitivity, 90% specificity and a positive predictive value of 77.8%. In the present study, the sensitivity of 51.6% of SFH in detecting SGA using EFW as gold standard is adequate to recommend its use for screening fetal growth deviation during prenatal care. The sensitivity of 85.7% of the SFH in detecting SGA in newborns of

Table 3. Performance of the symphysis-fundal height curve for the diagnosis of small for gestational age and large for gestational age (n=122) with the neonatal weight curve as the gold standard and comparison with the symphysis-fundal height curve of the Brazilian Ministry of Health. João Pessoa, Northeastern Brazil, 2006.

Symphysis-fundal height	Neonatal Weight			
	SGA		No-SGA	
SGA	12		7	
No-SGA	2		101	
Total	14		108	
	LGA		No-LGA	
LGA	8		20	
No-LGA	10		84	
Total	18		104	
Performance	SGA		LGA	
	SFH curve (%)	BMoH curve (%)	SFH curve (%)	BMoH curve (%)
Sensitivity	85.7	42.9	44.4	88.9
Specificity	93.5	99.1	80.8	51.0
Positive predictive value	63.2	85.7	28.6	23.9
Negative predictive value	98.1	93.0	89.4	96.4

SGA: small gestational age; LGA: large gestational age; SFH: symphysis-fundal height; BMoH: Brazilian Ministry of Health

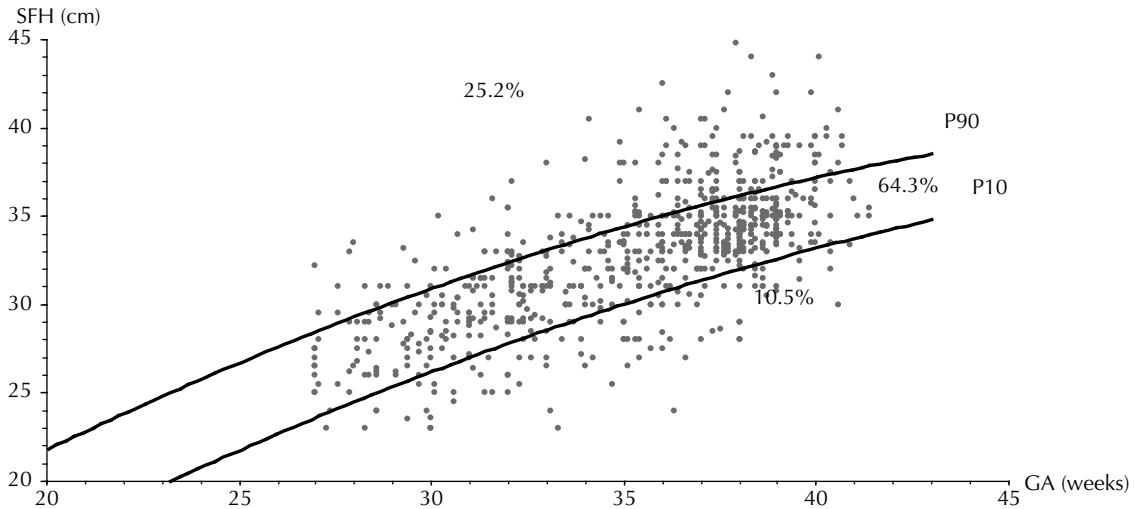
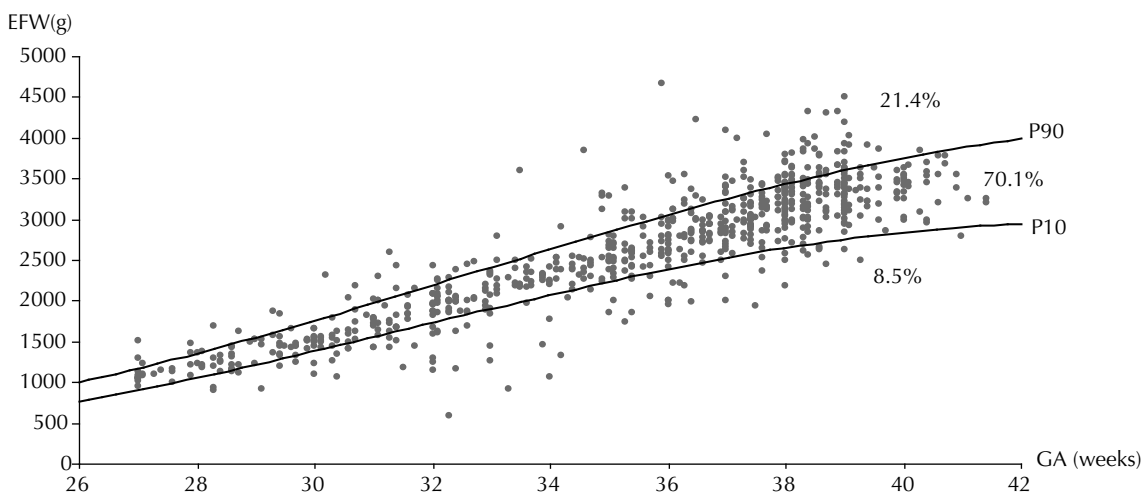


Figure 1. Distribution of 753 symphysis-fundal height measurements for the 10th percentile and the 90th percentile of Freire's curve. João Pessoa, northeastern Brazil, 2006.

this study supports this recommendation as it shows a higher performance than that of the BMoH standard curve. Villar & Belizan²³ and Engstrom & Sittler⁸ studies also indicated that SFH is an important and helpful measurement in the clinical diagnosis, not only in the screening of fetal growth deviation, but also to identify complications during pregnancy and errors in estimating gestational age. The charts may help identify low weight fetuses and allow appropriate interventions during prenatal care.

Fescina et al⁹ reported 50% sensitivity and 93% specificity and concluded that SFH measurement is an excellent method to identify fetuses with adequate weight for gestational age. This curve was accepted as a reference

standard for Latin America and the Caribbean in 1984, and later by the BMoH.^a Since high sensitivity is a key characteristic of a good screening method, the use of this curve currently recommended by the BMoH in Brazil may be, at least, questionable. Even though a sensitivity of 51.6% is lower than that desired for an excellent screening method, Freire et al's curve¹⁰ has performed better than the BMoH curve in the clinical practice context. Other Brazilian studies also showed better performance of other curves^{19,21} in comparison to that of the BMoH curve, supporting the recommendation to validate curves directly derived from Brazilian populations. Maybe these curves would be more appropriate in Brazil, improving the probability of screening fetal growth deviations when used as a diagnostic



EFW: estimated fetal weight; GA: gestational age

Figure 2. Distribution of 753 estimated fetal weight measurements for the 10th percentile and the 90th percentile of Cecatti et al. curve. João Pessoa, Northeastern Brazil, 2006.

resource in prenatal care. Ideally, all measurements of these different studies could be pooled in a common Brazilian reference SFH curve.

According to Freire et al,¹⁰ the SFH growth curve of pregnant women from public hospitals in the city of João Pessoa significantly differs from the standard curve recommended by the BMoH.⁹ Some other studies have investigated curves developed from a Brazilian population of pregnant women, however these curves differ methodologically from the present curve, especially in the SFH measurement technique and variation between examiners.¹⁸

Although Neilson²⁰ claimed there is a lack of evidence indicating any real benefit of using SFH measurement in prenatal care, many countries have prenatal care protocols recommending its use along with reference curves designed for the population of interest.^b Despite technological improvements, the real benefit of obstetric ultrasound, when used in the clinical routine as a screening method for fetal growth restriction in low-risk populations, is not yet supported by strong scientific evidence.^{2,14} Considering that even in developed countries it is estimated that approximately 50% of SGA fetuses are only identified at birth or death, and that this number is likely to be higher in developing countries, it is reasonable to accept the use of a low-cost method like the SFH measurement, even without excellent sensitivity. In a recent study Lindqvist & Molin¹⁶ showed that SGA fetuses that were not diagnosed during prenatal care have a four times greater risk of developing unfavorable outcomes than those diagnosed during prenatal care. This data

emphasizes the need for assessing feasible screening methods that are appropriate to the reality of mother-infant health care.

One of the limitations of the present study is that we could not correlate neonatal outcome in the entire sample as only 122 cases (16.2%) had neonatal weight determined up to seven days after SFH and EFW measurements. However, a high linear correlation between EFW and neonatal weight ($r = 0.94$) was found in this subsample, which was considered to be more than enough to ascertain a strong association.¹¹ Therefore, this finding supported the classification of EFW as the gold standard to diagnose fetal growth deviation in this study. Another limitation is regarding its cross-sectional design. As each pregnant woman had her SFH measurement assessed only once, it was not possible to evaluate the individual standard of SFH growth. Hypothetically, some undetected cases of SGA (false negatives) could have a reduction of SFH between two consecutive measurements. This hypothesis is consistent with new conceptual aspects of fetal growth restriction, which consider detecting a reduction in fetal weight a more important diagnostic criterion than the use of predetermined percentiles in fetal weight curves.^{3,7,22}

Based on these results, important questions are posed in the area of public health. For instance, what would be the economic and perinatal impact of using a new and better SFH curve in the Brazilian population? A nationwide cohort study on maternal weight gain and fetal growth patterns would be the desirable for better understanding this relationship.

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