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Delay in Growth in Adolescents: Clinical Validation of a Proposed Nursing Diagnosis

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ABSTRACT

Purpose: This study aims to analyse the accuracy of clinical indicators of the proposed diagnosis of delayed growth in school-aged adolescents.
Design and Methods: This is a diagnostic accuracy study of 385 adolescents in public schools from July to September 2017 that aimed to assess the accuracy of clinical indicators of the proposed nursing diagnosis of delayed growth; the sensitivity and specificity values were calculated using latent class analysis.
Results: Growth velocity less than expected was associated with sensitivity and specificity. The clinical indicator short stature for age and sex showed sensitivity. Low weight for age and sex, stature below genetic target and delayed sexual maturation were specific indicators.
Conclusion: In a sample of adolescents in public schools in northeastern Brazil, a set of five clinical indicators best indicated delayed growth in adolescents. Two clinical indicators showed sensitivity, and four clinical indicators showed specificity.
Practice implications: This study contributes to refining the diagnostic proposition of delayed growth in adolescents. Accurate measures for nursing diagnoses can help paediatric nurse practitioners confirm or exclude this diagnosis in adolescents with a similar profile.

Introduction

Adolescence is a complex stage that is characterized by physical and psychosocial growth, increased cognitive abilities and development of personal and social identity (Chulani & Gordon, 2014; Hochberg & Belsky, 2013). This stage corresponds to the age group of 10 to 19 years.

The growth of adolescents involves a complex interaction of activating and inhibitory factors in the hypothalamic-pituitary-gonadal axis and adrenal gland (Fisher & Eugster, 2014). Genetic, racial, cultural, lifestyle and socioeconomic factors can cause delayed growth (Yadav & Dabas, 2015).

Studies estimate a prevalence of 10% of adolescents with short stature for age and sex, which characterizes a delay in growth (El Mouzan, Al Salloum, Foster, & Al Omer, 2011; (Ramires et al., 2014). This problem can cause anxiety, depression, low self-esteem, isolation and a lack of participation in school life (Butler & Yingling, 2013).

Evaluating the factors that interfere in the normal course of growth in adolescents is important because the patterns and changes in this age group shape their future trajectory (Savage et al., 2016; Sawyer et al., 2012). Clinical evaluation of adolescents performed by nurses is considered effective follow-up of this condition (Butler & Yingling, 2013). Recognizing a delay in the growth of these individuals by identification of clinical indicators facilitates interventions and can minimize sequelae in adult life.

Thus, clinical evaluation allows the identification of nursing diagnoses, that are represented by standardized terms, such as those recognized by NANDA - International. These terms, though standardized, require successive revisions. In the 2012–2014 version, this taxonomy included the nursing diagnosis delayed growth and development. However, in the 2018–2020 edition, this nursing diagnosis was excluded because of the need for further research that separately analyses growth and development in different scenarios (Herdman & Kamitsuru, 2014).

Concept analyses such as those of Andriola (2016) and Delgado (2016) respectively defined the terms growth and development separately as follows: "Growth below expectations for individuals from 10 to 19 years of the same sex: height below the 3rd percentile or deficit

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in height above 2 standard deviations, which, associated with decreased growth velocity, results in the final height below the genetic target" (Andriola, 2016) and "Below-expected development for individuals between 10 and 19 years, caused by cognition deficit, and/or behavior and/or physical" (Delgado, 2016).

Nursing diagnoses need to be valid, comprehensible and useful in clinical practice because they represent human needs, allowing for quality of care (de Carvalho et al., 2008). Thus, to confirm the above findings, this study aims to clinically validate the delay in growth. It is necessary to stimulate the development of clinical validation studies to legitimize nursing problems in clinical practice (Lopes, da Silva, & Araujo, 2012). The precise establishment of a nursing diagnosis is based on scientific evidence and enables qualified care.

Therefore, this study aims to analyse the accuracy of clinical indicators of the proposed diagnosis of delayed growth in school-aged adolescents, which is important because this information provides robust evidence for paediatric nursing practices.

Methods

Design and sample

This is a diagnostic accuracy study based on measures of sensitivity and specificity of clinical indicators. The study of the accuracy of nursing diagnoses describes the power of each clinical indicator to correctly differentiate individuals with a diagnosis from those without that diagnosis. This reference standard is an advanced method that uses complex techniques of sampling, data collection and analysis to answer questions that refer to the representativeness of elements of a nursing diagnosis. Thus, this study can generate strong clinical evidence that directs nursing care, which can achieve better health outcomes (Lopes et al., 2012).

This study was performed in reference public schools in northeastern Brazil from July to September 2017. Data collection was initiated after approval by the ethics committee.

The sample size was determined by a predefined constant for the clinical indicators investigated (Swanson, Lindenberg, Bauer, & Crosby, 2011). In this study, the constant was 55, and the diagnostic proposition, delayed growth, had seven indicators. Thus, the sample size was 385 adolescents.

The inclusion criteria were adolescents who were between 10 and 19 years old and who resided with their biological parents. Adolescents who did not have an adequate physical and/or mental state to answer the questions were excluded.

Data collection

This study used a self-designed instrument for data collection that included socio-demographic variables and questions related to clinical indicators of the proposed diagnosis of delayed growth (delayed sexual maturation; decreased bone mass for age and sex; stature below genetic target; growth velocity less than expected; low weight for age and sex; and short stature for age and sex). The instrument was developed from clinical indicators and conceptual and empirical definitions created in previous studies (Andriola, 2016).

The clinical indicator pubertal growth spurt was also identified by Andriola (2016). However, it was not evaluated because it was not possible to conduct radiography in adolescents. Data were collected through a physical examination and interview conducted during the second half of 2017.

Data analysis

Data were statistically analysed using statistical package R, version 3.0.2 (R Core Team, 2014). The accuracy of clinical indicators was measured by latent class analysis.

In latent class analysis, a latent variable that cannot be directly observed (the diagnostic proposition delayed growth in adolescents) determines the relationships between observable variables (clinical indicators) (Lopes & Silva, 2016). These relationships are described by measures of diagnostic accuracy that allow the identification of indicators with high sensitivity (initial clinical signs of diagnosis) or high specificity (confirmatory indicators of diagnosis) (Lopes et al., 2012).

The diagnostic accuracy measures were analysed regarding the degree of significance of their confidence interval, where a value greater than 0.5 was found for sensitivity and/or specificity (Lopes et al., 2012). The prevalence of the diagnostic proposition, delayed growth in adolescents, was verified based on the occurrence of clinical indicators.

To assess the accuracy of clinical indicators, a proposed diagnostic model centred on two latent classes of random effects was used to calculate the sensitivity and specificity with a 95% confidence interval. In addition, the likelihood ratio test (G2) was applied to verify the suitability of the adjustment of the latent class model.

Initially, a null latent class model was adjusted with all clinical indicators that were measured for the diagnostic proposition delayed growth in adolescents. Using this adjusted model, it was possible to identify the indicators that showed the worst performance, which were evaluated first based on the lack of statistical significance of their confidence intervals and then according to low values of the area under the receiver operator curve (ROC). Due to their undesirable performance, the indicators were sequentially removed from the data set (Collins & Lanza, 2010).

Thus, the adjusted model included the prevalence of the diagnostic proposition delayed growth in adolescents for this data set, as well as the sensitivity and specificity values of clinical indicators, which behaved as expected in the statistical analysis.

The measurement of clinical indicators proposed for adolescents allowed us to test their accuracy, and it was possible to identify those that better predicted the diagnostic proposition delayed growth in adolescents in public schools in northeastern Brazil.

Results

The most frequent clinical indicators of the nursing diagnosis delayed growth in adolescents in this study were delayed sexual maturation (32.2%), decreased bone mass for age and sex (24.7%) and stature below genetic target (14.3%) (Table 1).

Measures of diagnostic accuracy

The null latent class model presented all the clinical indicators of the diagnostic proposition delayed growth in adolescents. However, the indicator decreased bone mass for age and sex was not significant. Thus, this clinical indicator was sequentially excluded by adjusting the latent class model (Table 2).

The clinical indicator short stature for age and sex (99.41%) and growth velocity less than expected (99.94%) presented sensitivity for the delayed growth in adolescents. The indicators low weight for age and sex (96.32%), stature below genetic target (86.09%) and delayed sexual maturation (68.51%) presented specificity for the proposed diagnosis. Importantly, the clinical indicator growth velocity less than

Table 1
Prevalence of clinical indicators of the nursing diagnosis delayed growth in adolescents.

Clinical indicators	N	%
Delayed sexual maturation	124	32.2
Decreased bone mass for age and sex	95	24.7
Stature below genetic target	55	14.3
Growth velocity less than expected	22	5.7
Low weight for age and sex	14	3.6
Short stature for age and sex	6	1.6

Table 2
Accuracy measurement of clinical indicators of the diagnostic proposition delayed growth in adolescents.

Clinical indicators	Sensitivity (95% CI)	Specificity (95% CI)	
Short stature for age and sex	0.9941 (0.7108–1.0000)*	0.9973 (0.0433–0.9999)	
Low weight for age and sex	0.0005 (0.0000–0.0068)	0.9632 (0.9351–0.9779)**	
Stature below genetic target	0.4003 (0.0063–0.9957)	0.8609 (0.8193–0.8921)**	
Delayed sexual maturation	0.8008 (0.0004–0.9983)	0.6851 (0.6291–0.7301)**	
Growth velocity less than expected	0.9994 (0.9820–1.0000)*	0.9554 (0.6129–0.9933)**	
Prevalence: 1.3%	G^2: 24.89	gl: 20	$p = 0.205$

CI: Confidence interval. * Clinically indicators sensitive; ** Specific indicators.

expected presented significant values for both sensitivity and specificity. Thus, this indicator represented the best measure of accuracy to infer the proposed diagnosis. The prevalence of the diagnostic proposal of delayed growth in adolescents was estimated by the latent class model as 1.3%.

Discussion

Delayed growth is defined by growth that is less than that expected for individuals of the same sex in the age group of 10 to 19 years. This is a nursing diagnosis proposition that needs to be extensively investigated for accurate identification in clinical practice (Andriola, 2016; Lucio, 2016).

The literature demonstrates the need to study the complexity of the factors that can cause growth retardation. The main factors are inadequate metabolic control and disorders of puberty, which can profoundly impact physical and psychosocial well-being (Klein, Emerick, Sylvester, & Vogt, 2017; Plamper et al., 2017). The clinical suspicion of growth impairment should prompt professionals to review the clinical, family and social histories of the adolescent and indicates the need for a physical examination (Rogol & Hayden, 2014).

In the present study, growth velocity less than expected was associated with sensitivity and specificity. The clinical indicator short stature for age and sex showed sensitivity. Low weight for age and sex, stature below genetic target and delayed sexual maturation were specific indicators. Clinical indicators with sensitivity are useful to initially suggest the diagnosis, and indicators with specificity are confirmatory of the diagnosis.

The indicator growth velocity less than expected best represents the diagnostic proposition of delayed growth. This indicator is important in the evaluation by nurses because it will be present in patients with a diagnosis of delayed growth and will be absent without this diagnosis. The velocity of growth increases at approximately ages 14 and 12 in boys and girls, respectively (Amin, Mushtaq, & Alvi, 2015).

Maximal growth occurs during Tanner stage 4, and during this period, extensive muscle and bone mineral mass formation occurs (Cairo, Silva, Bustani, & Marques, 2014). Thus, the investigation of this indicator by paediatric nurse practitioners represents the opportunity for clinical and public health interventions to maximize peak muscle and bone mineral mass formation in adolescents to prevent a delay in growth (McCormack et al., 2017).

The clinical indicator short stature for age and sex presented sensitivity values, which help to initially suggest the diagnosis. Stature is influenced by genetic and environmental factors. The environmental factors that determine stature include parental education, socioeconomic conditions, disease and nutrition (Prendergast & Humphrey, 2014). Obesity was associated with short stature and reduced growth during adolescence (Komlos & Lauderdale, 2007). Additionally, malnutrition is the most common factor due to the lack of ingestion or malabsorption of essential dietary elements (Black et al., 2013; Prendergast & Humphrey, 2014).

The clinical indicator low weight for age and sex was confirmatory of delayed growth in adolescents. Research conducted in 60 countries found that the prevalence of underweight in adolescents was less than 5%, which is similar to the value found in this study (3.6%) (Akseer, Al-gashm, Mehta, Mokdad, & Bhutta, 2017). This finding reinforces the relevance of nutritional assessment by paediatric nurse practitioners and its influence on growth problems in adolescents.

The indicator stature below genetic target was identified in this study as confirmatory for growth retardation in adolescents. In addition to its genetic character, target stature is also related to other factors such as weight. Research indicates that obese or overweight adolescents have an increased risk of reaching an end stature below the genetic target compared to normal weight adolescents (Pinhas-hamiel et al., 2017). Thus, the identification of genetic targets and other factors such as obesity helps nursing practitioners to confirm the occurrence of delayed growth in adolescents.

The clinical indicator delayed sexual maturation presented specificity for the studied diagnosis as a confirmatory indicator of delayed growth. Sexual maturation is a part of puberty and is the period in which physical and psychosocial growth occurs. Late or early puberty is common in clinical practice (Pinyerd & Zipf, 2005).

In late puberty, sexual maturation is not observed in boys until 14 years of age and in girls until 13 years of age. No secondary sexual characteristics are present, such as the increase in the testicles in boys and the development of breasts in girls. Late puberty results from inadequate secretion of gonadal steroids due to disturbances in the pituitary, hypothalamus and gonads (Lazar & Phillip, 2012; Pinyerd & Zipf, 2005). The evaluation of sexual maturation is an important part of adolescent care and should be incorporated into the clinical routine of nurses (Chipkevitch, 2001).

In nursing consultations, paediatric nurse practitioners can observe the presence of delayed sexual maturation based on Tanner's criteria. Tanner defines delayed sexual maturation as any pubertal development that is 2 standard deviations (SD) below the mean used to define the limits of normal variability (El Badri, Rostom, Bouaddi, & Hajjaj-Hassouni, 2014).

The results of this study contribute to the refinement of the proposed nursing diagnosis delayed growth in adolescents by identifying accurate clinical indicators. In clinical practice, these findings may suggest the best indicators for this diagnosis for the provision of better-targeted nursing care.

Limitations

The cross-sectional approach, which is concentrated at a single timepoint, limited the monitoring of some clinical indicators that would be best represented longitudinally. Furthermore, the scarcity of studies examining nursing diagnoses in adolescents made the comparison of study results difficult. Thus, we suggest the development of longitudinal studies to compare and enrich the present findings.

Another limitation involves one of the clinical indicators. The clinical indicator pubertal growth spurt was not evaluated because this study did not have sufficient financing to perform radiography. Other studies with funding support can be conducted to measure all clinical indicators of the nursing diagnosis delayed growth in adolescents.

In addition, this study was conducted on adolescents in public education institutions in a specific region of Brazil. Therefore, the characteristics inherent to adolescents living in this location, such as genetic, racial, cultural, socioeconomic and lifestyle factors, may have influenced

the identified results. Thus, this limitation must be considered when extrapolating these data to other regions of the world. Further research is suggested to verify these results.

Conclusion

Growth velocity less than expected was the most precise measure of the presence of the proposed nursing diagnosis delayed growth in a sample of adolescents in public schools in northeastern Brazil. The clinical indicators short stature for age and sex, low weight for age and sex, stature below genetic target, growth velocity less than expected and delayed sexual maturation were associated with an increased probability of the presence of this diagnosis.

These results will help nurses in paediatric clinical practice to confirm the proposed diagnosis of delayed growth in adolescents with a similar profile. In addition, this research may contribute to the refinement of the NANDA - International taxonomy and refine clinical practice based on scientific knowledge.

Conflict of interest

No conflict of interest has been declared by the author.

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Author contributions

[a]KDBL - 1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

[b]ICA – 1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

[c]JDST – 1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

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[g]MVOL - 1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

[h]ALBCL - 1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

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