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Review Article

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Reappraisal of Regional Growth Charts in the Era of WHO Growth Standards

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After the WHO Growth Standards (WHOGS) was published in 2006, many countries in the world endorsed and adopted the new growth references as a standard measure for the growth of infants and young children. Certainly, the WHOGS has an impact on the global policy about obesity and underweight in children. Such WHOGS innovation has influenced many regional health authorities and academies, which have managed their own growth charts for a long time, in changing their strategies to develop and use regional growth charts. In Korea, along with the tradition to create a national growth chart every decade, we now face a new era of advancing with the WHOGS. **(Pediatr Gastroenterol Hepatol Nutr 2013; 16: 137～142)**

Key Words: World Health Organization Growth Standards, Growth charts, Obesity, Underweight, Korea

INTRODUCTION

World Health Organization (WHO) has published the current WHO Growth Standards (WHOGS) in 2006 [1]. These innovative charts are completed with vigorous efforts to elucidate the physiologic human growth in the era of 'double burden of malnutrition'. Underweight and overweight have been important health issues both in developed and developing countries for decades, especially where disparity in children's health is concerned. WHOGS has the scientific evidences to inform individuals, groups, and governments about the fact that data on deviated body sizes according to WHOGS could be a real pathologic sign [2-5]. Many countries in the world nowadays have endorsed WHOGS as their national reference [4]. However, some countries still have doubts and debates in this valuable guideline [6,7]. In the following short review, issues about the endorsement of WHOGS and value of regional growth charts in the era of WHOGS will be discussed in relation to Korean growth reference.

HISTORY OF KOREAN GROWTH CHARTS

In Korea, there has been a long history of making

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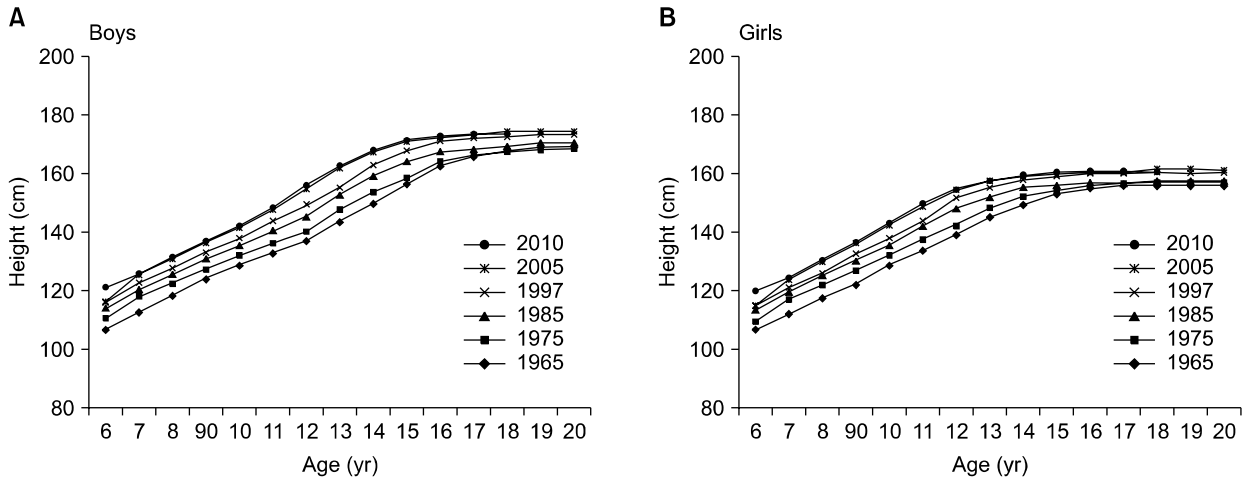

Fig. 1. Plotted mean height from 6 to 20 years showed pronounced changes from 1965 to 1997 (boys in [A], girls in [B]). This pattern of secular change has varied. There was almost no change from 1997 to 2010. In mid adolescents, growth acceleration in puberty appeared rapid during the decades. Adapted from Moon (Korean J Pediatr 2011;54:436-42) with permission [13].

our own growth charts for children and adolescents since the 1960s [8]. The Korean government and the Korean Pediatric Society have revised the national growth charts nearly every 10 years according to the rapid anthropometric changes in Korean children and adolescents [9-12]. There have been huge socioeconomic changes within Korea compared to other countries in the world during the last 60 years in conjunction with greater changes in children's body size [13]. Korean growth charts were made descriptively based on the nationwide anthropometric survey, which was performed every 10 years prior to growth charts revision (Fig. 1) [13]. Height, weight and body mass index (BMI) have increased dramatically across the spectrum, from the deprived to the affluent levels, and growth charts adapted the changes as well. Korean growth charts have functioned mainly as a reference chart, rather than as a standard, in clinical fields because they seldom had physiological implications. Characteristic features of our growth charts so far include a simple description of population body size, charts based on cross-sectional data and 'with-in 10 years of expiration date'. There was no notion about 'physiologic standard based on ideal feeding and environment that does not constrain human growth' in our growth charts in contrast to the WHOGS. In the absence of a physiologically relevant growth standard, which could be used universally, the Korean growth chart had been regarded as a sophisticated way to use descriptive and specific charts for a specific generation living in a specific region [2].

2007 KOREAN GROWTH CHARTS

The latest Korean version (2007KR) was published in November, 2007 and has been endorsed by the Korean health government until now (Fig. 2) [12]. In this 2007 version, we made several changes to cope with the obesity epidemic in Korea. For the first time, we discarded the simple descriptive method. The charts were based on raw data from both 1997 and 2005 to adjust the recent secular increment in weight. However, we had taken into account height and weight in a different manner than the year 2000 version released by the US Centers for Disease Control and Prevention (USCDC). USCDC did not use the latest weight data from National Health and Nutrition Examination Survey (NHANES) III, which showed the evident effects of overweight [14]. In contrast, the 2007KR 'did' use the latest weight data from 2005 nationwide survey, because 95 percentile

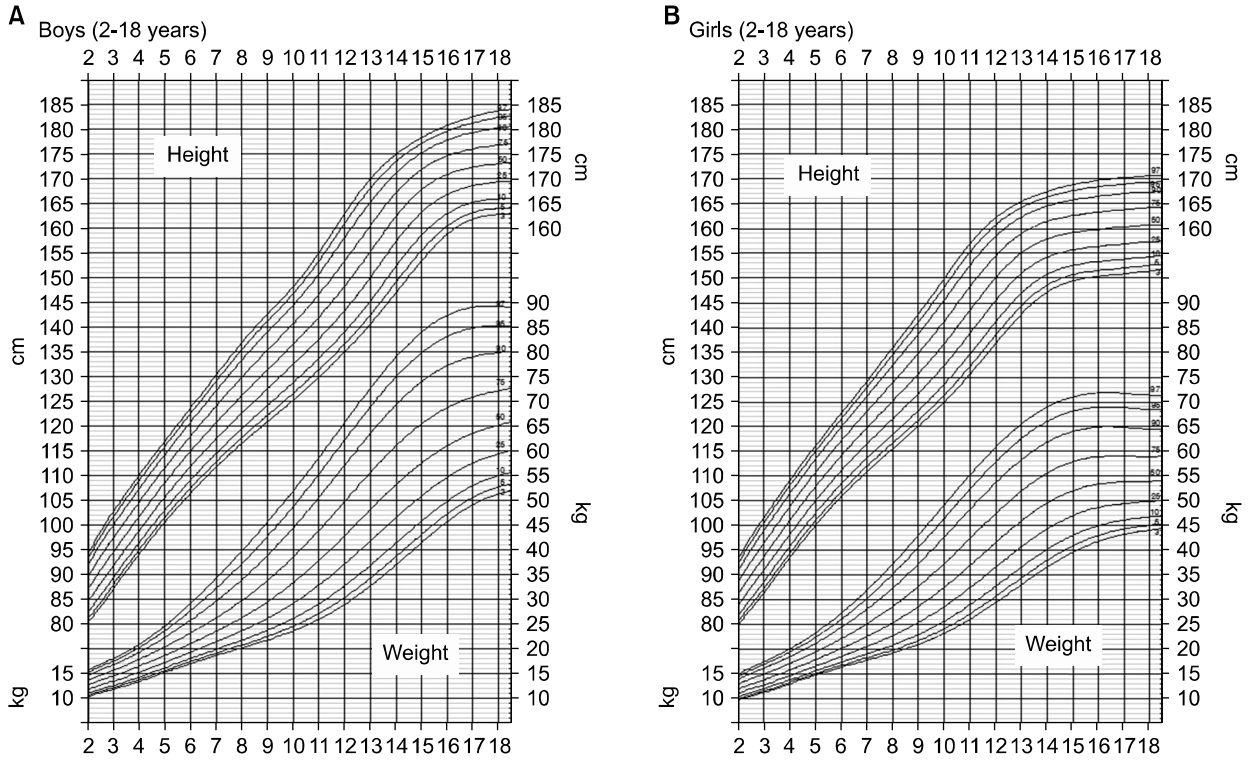

Fig. 2. The latest Korean growth charts was published in 2007. Two selected charts for children above 2 years old are as above. Adapted from Moon et al. (Korean J Pediatr 2008;51:1-25) with permission [12].

both in boy's and girl's BMI were below 30 even in the late adolescents. In addition, the 2007KR adopted LMS methods and locally weighted regression to make a cutting edge chart [15]. A secular trend of earlier onset of puberty than previous decades, so-called growth acceleration phenomenon, is also prominent in these descriptive charts. Consequently in comparison with WHOGS and USCDC, Korean growth charts demonstrate relatively higher height and heavier weight in infancy and heavier BMI in the early adolescents [12]. Final adult height and BMI is almost similar to USCDC.

WHO GROWTH STANDARDS

Faced with the global epidemic of obesity and undernutrition, WHOGS considered breast feeding as a biological 'norm'. These charts were made to state, "how children should grow" and frequently described as "prescriptive charts" [1,16,17]. Even though WHOGS was based on the fact that infant growth are very similar among diverse ethnic backgrounds, there were concerns especially in Asian countries, as the Multicentre Growth Reference Study omitted several Eastern Asian countries with large population such as China, Korea and Japan [18]. However, with the advance of infant nutrition, it has been more evident that the WHOGS should be used universally. Malnutrition in fetus and early infancy could be related to future detrimental health outcomes [19-21]. Undernutrition during such a vulnerable period usually corresponds with decreased metabolic capacity and greater susceptibility to metabolic overloads. Early protein loads and accelerated growth pattern are also regarded as important determinants of later metabolic morbidities [22,23]. Many academic societies endorsed the WHOGS and stated that the WHOGS should be used for all children aged under 5 years in every country regardless of their feeding pattern [2,4]. There still remain limi-

tations in the WHOGS [2]; for the school-aged children and adolescents, WHO has no answer especially regarding the physiological norm. In response, WHO published a new WHO growth reference for this age group in 2007, which was based on re-analysis of the National Centre for Health Statistics data from 1977 [24]. This reference chart could be used as a global reference for an international comparison.

UK–WHO GROWTH STANDARDS AND OTHER NEW APPROACHES

The Royal College of Paediatrics and Child Health (RCPCH) in the United Kingdom (UK) endorsed the WHOGS after 2 weeks of age because their birth weight revealed a discrepancy with the WHOGS [5,25-27]. This UK-WHO Growth Standards (UKWHO) suggests a model for the nations which have developed their own growth references. The RCPCH has also recently published new charts for school-aged children and adolescents which incorporated the 'shadowed area' to mark the pubertal effects on the growth charts [28]. These are the first official charts which reflect the physiological significance to the conventional cohort based growth charts of the adolescents. To clarify the healthy growth in preterm and low birth weight infants, a novel approach for the preterm and fetus, or Intergrowth-21st, has been made [29-31]. This study, which was conducted in Oxford, is a multinational, optimally intervened population study such as the WHOGS. New 'prescriptive' charts for preterm and fetus will be available in the near future.

CONCLUSION

The WHOGS is the first growth chart which can be considered as a physiological "Standard". It adopted innovative methodology and delivered brilliant outcomes up until now [4,32]. The biggest impact made by the WHOGS is that it has triggered new waves among the academic societies in human nutrition and health policy towards a better early infant nutrition in many countries throughout the world [3,7,33,34]. Regional growth references like the 2007KR still have their role especially in the school-aged children and adolescents, who live in regions where the charts were developed; however, the cost of developing regional growth charts may be higher than adopting the universal growth charts, and the concept "physiologically norm" should be taken into account before and after the implementation of regional chart to the fields. Further research on regional growth charts is needed to cope with the obesity epidemic and nutritional disparity. Collaborations and communications among bodies which have conducted new approaches toward human growth from fetus to adolescents would be necessary to share experience and to save budget as well as time. Data collection in conjunction with a well-organized scientific intervention for healthy nutrition and exercise in a population of school-aged children and adolescents would be necessary to achieve the 'Standard' data in these age groups.

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