Paradigm Academic Press
Journal of Innovations in Medical Research
ISSN 2788-7022
JUN. 2023 VOL.2, NO.6

Ponderal Index: An Important Anthropometric Indicator for Physical Growth

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doi:10.56397/JIMR/2023.06.03

Abstract

The Ponderal Index (PI) is an essential measure to study physical growth of fetus, infants, newborn babies, adolescents, and adults. Lower PI is found among the malnourish infants and newborn babies and higher in obese ones. PI is also applied in maternity treatment to detect impaired fetal growth. Neonatal PI is essential to identify the effects of gestation age, sex, and maternal parity. In this study aspects of Ponderal Index (PI) are discussed to increase the measurement area for the reduction of risk factors of the infants and children morbidity and mortality.

Keywords: Ponderal Index, malnutrition, fetal growth, infants, newborn babies

1. Introduction

The Ponderal Index (PI) or Corpulence Index (CI) is a measure of corpulence or leanness of a person. It was first proposed in 1921 by Swiss physician Fritz Rohrer (1888-1926). According to him it is known as Rohrer's Index (Rohrer, 1921). It is found by a simple calculation from standard anthropometrical measurements and commonly used in pediatrics. The two main factors: height and weight of a person are required to calculate PI (West, 2019).

The PI is a measure of the relationship between birth-weight and body length; the famished child, with a low body weight relative to length should have a lower PI (Chard, 1997). BMI is an ideal and preferred body weight index measure for many populations worldwide, while PI is considered a poor approach. PI gives more accurate result compared to the BMI but is not widely used (Komaroff, 2017).

2. Literature Review

In any type of research, literature review is an introductory area, where works of previous researchers are included (Polit & Hungler, 2013). It deals with a secondary research sources and does not think about coming research work (Gibbs, 2008). New researchers find a proper guideline from this section to start their research with confidently through the understanding of the subject area (Creswell, 2007). Jonathan V. Roth has compared the Corpulence Index (CI) and Body Mass Index (BMI) with some examples. In the study he proposes that taller patients (adults) should have as their normal a higher BMI and a higher blood pressure, and the converse for shorter people (children) (Roth, 2018).

Jae Kyoon Hwang and his coauthors have tried to evaluate how intrauterine stress affects extremely premature infants in terms of intrauterine growth restriction. They have noticed that extremely premature infants with mildly-low Ponderal Index (PI) would have better neonatal outcomes (Hwang, 2022). Karel Hajniš and his coauthors have aimed at the investigation of the ontogenetic development of thickness of five skinfolds on the

trunk in children in relation to Rohrer's Index of body fullness (Hajniš, 1983).

Syuro Ito and his coworkers examine the relation between children's Rohrer Index and their motor ability demonstrated in physical fitness tests. They confirm that children require exercise and physical activity that correspond to their physical development (Ito, 2020). Tim Chard and his coworkers try to determine the relationship between birth-weight and anthropometric indices, such as Ponderal Index (PI), mid-arm circumference (MAC), and occipito-frontal circumference (OFC); in preterm infants, but Ponderal Index is not correlated with none. Hence, measurement of the Ponderal Index does not provide a useful index of intrauterine nutrition (Chard, 1997).

3. Research Methodology of the Study

All academicians take the research as a challenging work to lead in academic world (Pandey & Pandey, 2015). A well-built outline of the study and an efficient understanding are crucial to reach the goal of a research (Tie et al., 2019). Methodology is a guideline to perform a good research that helps the researchers to increase the trust of a reader in the research findings (Kothari, 2008). Research methodology is the science and philosophy behind all researches that provide the principles for organizing, planning, designing and conducting a good research (Remenyi et al., 1998; Legesse, 2014). In this study we have discussed Ponderal Index for adults and then for infants and children, and then we have provided limitations of Ponderal Index. To prepare this paper we have used various materials from secondary data sources (Mohajan, 2017).

4. Objective of the Study

Main objective of this study is to discuss the nature of Ponderal Index (PI). Other minor objectives of the study are as follows:

- to write and explain the formulae of PI, and
- to provide the limitations of PI.

5. Ponderal Index for Adults

Ponderal Index (PI) for adult is defined as (Fayyaz, 2005),

$$\mathrm{PI}_{\mathrm{adult}} = \frac{\mathrm{mass}_{\mathrm{kg}}}{\mathrm{height}^{3}_{\mathrm{m}}}, \tag{1}$$

where mass is

measured in kilogram and height is measured in meter, hence unit of PI is kg/m^3 which is same as the unit of density (Ditmier, 2006). The normal measure of PI for adults is 12 and that is for a newborn child or infant is 2.4. Also the normal ranges of the PI are; 11 to 15 for adults and 2.2 to 3.0 for newborn babies irrespective of weeks of gestation, child's sex, and maternal parity (Roth, 2018). Higher PI indicates overweight and obese, and their related non-communicable diseases, such as hypertension, cardiovascular diseases, Alzheimer disease, asthma, metabolic syndrome, liver steatosis, gallbladder disease, osteoarthritis, obstructive sleep apnea, certain types of cancer, hypercholesterolemia, metabolic syndrome, musculoskeletal disorders, and type 2 diabetes among adults (Mohajan & Mohajan, 2023a, b, c). There is a common believe that many preterm infants are growth-retarded and immature. But PI supports that this is not true always (Chard, 1997). Categories of PI of adults are given in Table 1.

Table 1. Ponderal Index for Adults.

Category	PI (kg/m^2)
Underweight	8–11
Normal range	11–15
Overweight	15–17
Obese	>17

Source: Ditmier (2006).

6. Ponderal Index for Children

For infants and newborn babies, mass is usually measured in grams and height in centimeters. Ponderal Index (PI) for child is defined as,

$$\mathrm{PI}_{\text{child/fetal}} = 100 \times \frac{\text{mass}_{\text{g}}}{\text{height}^3_{\text{cm}}} = 0.1 \times \mathrm{PI}_{\text{adult}} \,. \tag{2}$$

Infant PI is used in pediatrics to observe whether a newborn baby is malnourished, healthy, or overweight, or the fetus growth is poorly in the mother's womb. If Ponderal Index (PI) of an infant lies below the 10th percentile, it is intrauterine growth retardation (IUGR) (Fayyaz, 2005).

Lower PI of an infant indicates malnutrition. On the other hand, higher PI has especially high risk of obesity and its related diseases (Crusell et al., 2017). Higher PI also indicates overweight in adolescents. PI divides the newborn infants into three categories as; malnourish, normal healthy, and obese (Beck et al., 1999). If an infant's soft tissue mass is below the normal stage of skeletal development; by Ponderal Index (PI) measure it is considered as malnourish (Fayyaz, 2005). Categories of PI of infants and children are given in Table 2.

Table 2. Ponderal Index (PI) for newborn infants and children

Category	PI (kg/m^3)
Very low	1.2
Low	1.3–1.19
Middle	1.20–1.25
Upper middle	1.26–1.32
High	1.33–1.39
Very high	≥1.40
Healthy range	1.2–1.6

Source: Banik (2011).

7. Ponderal Index for Fetus

Ponderal Index (PI) has been used for assessing fetal growth. It is one of the anthropometric methods used to diagnose impaired fetal health. Ponderal Index (PI) for fetus is same as that of children and is defined as (Rose, 2004),

$$\mathrm{PI}_{\text{fetus}} = 100 \times \frac{\text{mass}_{\text{g}}}{\text{height}^3_{\text{cm}}} \,. \tag{3}$$

Fetal growth is affected by ethnicity, geographic location, and socioeconomic position and gestation age is the most important factor for neonatal PI (Gruenwald, 1966). According to PI neonatal can be symmetric, i.e., the appropriate relationship between fetal length and fatal weight; or asymmetric, i.e., relatively greater fetal length than weight indicates leanness or relatively greater fetal weight than length indicates obesity. Therefore, PI indicates complete information of fetal pattern during gestation period (Beck et al., 1999).

8. Limitations of PI

Ponderal Index (PI) is an indicator and does not provide absolute measurement of human body. It cannot differentiate between male and female (Rose, 2004). A body builder with more muscle individual may be classified as overweight based only on weight and height proportion, actually s/he may be a healthy person. PI is not a superior predictor than BMI for selected short-term outcomes in new born (Tamim et al., 2004).

9. Conclusions

This study is a brief review on Ponderal Index that measures the physical growth of fetus and infants. We have observed that Ponderal Index has both advantages and weaknesses. PI appears to be a better measure of infants and children for the treatment of their risk factors. From the study we have realized that with a low PI an infant or child will be really an abnormal baby. Ponderal Index helps an infant for the proper growth development to build a strong future generation.

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