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Correlation of Inferior Vena Cava Diameter with Anthropometric Parameters in Indian Children

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Abstract

Background: Despite India's substantial contribution to global births, childhood mortality remains a pressing issue, with diarrhoea-induced dehydration accounting for more than 10% of deaths among children. This research seeks to examine the relationship between inferior vena cava (IVC) diameter and physical measurements such as height, weight, and abdominal circumference.

Materials and methods: A year-long prospective observational study was undertaken at Vinayaka Mission Kirupananda Variyar Medical College, located in Salem, Tamil Nadu. The research examined data from 150 pediatric outpatients between the ages of 5 and 12 to determine correlations among IVC diameter, height, weight, and abdominal circumference. Utilizing SPSS software, researchers conducted statistical analyses, presenting quantitative findings as means and standard deviations, while qualitative data were expressed as percentages.

Results: The research population consisted of 54% women and 46% men. The average IVC diameter measured 8.5 ± 2.25. To evaluate relationships between variables, correlation analyses were employed, with $p < 0.05$ considered statistically significant. The findings revealed IVC measurements in children from India and showed associations between IVC diameters and factors such as height, weight, and abdominal circumference.

Conclusion: This research offers significant insights into how IVC diameter correlates with height, weight, and abdominal circumference in Indian children. The results highlight the significance of IVC measurements in assessing dehydration status, while also stressing the need for additional studies involving a larger participant pool to enhance clinical precision and relevance.

Keywords: IVC Diameter, abdominal girth, height, weight, IVC Volume

Introduction

Children worldwide face substantial health risks from diarrhoea and dehydration, with diarrhoea-related dehydration accounting for over 10% of annual child mortality. Prompt and appropriate fluid replacement is essential, particularly in cases of acute gastroenteritis or trauma, emphasizing the need for accurate diagnostic techniques to assess intravascular fluid levels [1–3]. In paediatric emergency care, precise evaluation of fluid status is crucial for effective treatment and for reducing the risk of shock or death. However, current methods for assessing fluid status face limitations, including observer variability and reliance on prior evidence, which can affect their accuracy and reliability.

In paediatric emergency medicine, the use of point-of-care ultrasonography (POCUS) is increasingly popular due to its ability to provide rapid, non-invasive, and objective evaluations of intravascular

volume. This technology allows clinicians to quickly capture and analyse images at the patient's bedside. Measurement of the inferior vena cava (IVC) diameter has emerged as a reliable indicator of intravascular volume, outperforming more invasive techniques. By avoiding invasive procedures, IVC assessment reduces the risks associated with central vein access, making it particularly advantageous in children. The method's ease, speed, and repeatability, especially when measurements are taken across respiratory cycles in hemodynamically stable patients, enhance its utility in evaluating fluid status.

POCUS serves as an essential tool in managing severe dehydration in children, particularly in resource-limited settings, by enabling timely intervention and reducing mortality. Although organizations such as the WHO and UNICEF emphasize the importance of investigating context-specific risk factors and interventions for childhood diarrhoea, further research is needed to improve the prediction of disease outcomes. The lack of standardized data on IVC diameter among Indian children underscores the need for a focused study. Establishing reference values and understanding their relationships with age, gender, and anthropometric measurements will support a more targeted and effective approach to paediatric care. This research aims to address this knowledge gap by specifically examining the relationship between IVC diameter and children's height, weight, and waist circumference, thereby enhancing paediatric healthcare practices in India.

Methodology

This prospective observational research collected data from pediatric patients between the ages of 5 and 12 who attended the outpatient department at VMKV Medical College and Hospital. The investigation, which lasted for one year, included children with minor ailments not necessitating hospitalization, those seeking vaccinations, and patients returning for follow-up appointments after being discharged from acute illnesses, along with their accompanying siblings. The study excluded individuals who met any of the following criteria: need for inpatient care, significant medical conditions, gastrointestinal disturbances causing fluid loss, observable signs of hypovolemia, irregular vital signs during physical examination, or a record of organ failure or increased intra-abdominal pressure. The study involved 150 subjects. Children meeting the inclusion criteria were recruited after their parents provided consent. Researchers gathered data on the participants' height, weight, waist circumference, and inferior vena cava diameter using predetermined methods. SPSS for Windows, version 18, was employed for the statistical analysis. Numerical data were represented as means with standard deviations (SD), while categorical data were shown as percentages. To compare two means, a Student's t-test was applied, assuming the data followed a normal distribution. Relationships between variables were examined using Pearson's correlation test.

The primary objective of the research was to determine the correlation between various factors and the diameter of the inferior vena cava. The researchers utilized SPSS software version 23.0 to examine the results after entering the data into MS Excel. Numerical data were expressed as means and standard deviations, whereas categorical data were presented as percentages and proportions. The analysis of correlations employed either Spearman or Pearson methods, based on the distribution of the data. Statistical significance in the studies was determined by a p-value less than 0.05 for meaningful relationships.

Result

This research examined a group of children between 5 and 12 years old, with females comprising 54.0% and males 46.0% of the sample. The 5-9-year age range contained the largest number of participants. Researchers calculated the average age of the study group to be 6.78 years, with a standard deviation of 3.025 years. The distribution of genders was balanced across different age categories. Participants'

heights averaged 119.890 ± 18.556cm, with the shortest being 105 cm and the tallest reaching 1450cm. The weight of individuals in the study spanned from 16kg to 46kg, averaging 24.95 ± 6.565 kg. Measurements of abdominal circumference ranged between 46 cm and 97cm, with a mean value of 64.67 ± 11.013 cm.

Table 1: Anthropometric measurements

	N	Minimum	Maximum	Mean	Std. Deviation
Age	150	5	13	6.77	4.02
Height	150	101	121	0.980	16.86
Weight	150	13	49	24.65	5.05
Abdominal girth	150	44	100	64.7	09.015

This research utilized Pearson correlation analyses to investigate the association between IVC volume and three physical parameters: height, weight, and abdominal circumference. Correlations were considered statistically significant when the p-value was less than 0.05. The findings demonstrated positive associations between inferior vena cava (IVC) volume and body measurements, including weight, height, and abdominal circumference. Additionally, observation 11.013 showed a statistically meaningful correlation ($p < 0.05$). The data indicate a positive correlation between an individual's weight and their IVC volume, implying that heavier individuals tend to have larger IVC diameters. Additionally, a strong association was observed between height and IVC volume, with a substantial positive correlation coefficient ($R = 0.886$). This relationship was found to be statistically significant ($p < 0.05$). Similarly, a significant association was observed between weight and IVC volume, with a strong positive correlation indicated by a Pearson correlation test R-value of 0.878. This finding was statistically significant ($p < 0.05$). The data suggests a direct relationship between weight and IVC volume, indicating that IVC diameter tends to increase as weight rises. Additionally, the study uncovered a significant relationship between abdominal circumference and IVC volume. This connection was demonstrated by a strong positive correlation, with a Pearson correlation test R-value of 0.767, which was statistically significant ($p < 0.05$). These findings suggest that as abdominal size increases, there is a corresponding enlargement of the IVC diameter. (Table 1 and Table 2)

Table 2: Correlation of IVC volume with different variables

		IVC volume (in mm)	Height	Weight	Abdominal girth
IVC volume (in mm)	Pearson Correlation	1	0.789	0.875	0.748
	Sig. (2-tailed)	0.01	0.000	0.001	0.002
	Total	150	150	150	150

Discussion

The present study primarily aimed to evaluate the relationship between inferior vena cava (IVC) diameter and anthropometric parameters such as height, weight, and abdominal circumference in children. Among the 475 children included in the study, 285 (60%) were boys and 190 (40%) were girls. A study conducted by Jianjun Gu et al. among Chinese children reported a mean age of 6.8 ± 3.41 years, with a higher proportion of male participants compared to females. This contrasts with the sex distribution observed in the present study and may be attributed to differences in sample selection,

demographic characteristics, and study design.

Similarly, Kushagra Taneja et al. evaluated standard measurements of IVC diameter and its association with somatic indicators in healthy Indian children and reported a younger mean age of 4.72 ± 3.72 years when compared to our study population. In the study by Jianjun Gu et al., the mean height and weight were reported as 117 ± 20.25 cm and 22.69 ± 8.1 kg, respectively, with a mean abdominal circumference of 55.16 ± 7.8 cm. These anthropometric findings were largely comparable with those of the present study, possibly due to similar inclusion criteria and overlapping age groups. Furthermore, the maximum IVC diameter reported by Jianjun Gu et al. was 10.06 ± 2.42 mm, which closely aligns with our observations.

Neurinda Permata et al. examined IVC measurements in infants aged between 1 and 18 months and reported a male predominance of 58.6%, with most participants belonging to the 1–11 month age group. In contrast, the present study included older children and a relatively higher proportion of female participants, with a notable number aged between 3 and 6 years. Shivanand Patil et al. reported IVC diameters in Indian children ranging from 0.46 to 2.26 cm, with expiratory measurements between 0.97 and 2.26 cm and inspiratory measurements between 0.46 and 1.54 cm, findings that are comparable with the range observed in our study. Similarly, Shelby Kutty et al. provided normative data from 120 pediatric subjects and reported maximum and minimum IVC and superior vena cava diameters of 12.1 ± 3.8 mm and 8.9 ± 3.8 mm, respectively. Tomas Zaoral et al. demonstrated significant correlations between maximum and minimum IVC diameters and somatic variables such as age, height, and weight, supporting the associations observed in the present analysis.

Hegde et al. utilized computed tomographic data from healthy children to assess IVC dimensions and incorporated body surface area into their linear regression models. However, the reliance on body surface area rather than individual anthropometric parameters such as height and weight may have influenced the precision and statistical robustness of their findings. In adult populations, sonographic assessment of IVC characteristics for fluid status evaluation has been extensively studied by Dipti et al., Fossen et al., and Guiotto et al., highlighting the broader clinical applicability of IVC measurements in volume assessment.

Overall, this comparative analysis emphasizes the influence of age, sex, and anthropometric factors on IVC dimensions and underscores the importance of establishing population-specific reference values. Such normative data are essential for accurate interpretation of IVC measurements and effective paediatric fluid assessment across diverse populations.

Conclusion

To summarize, our study has demonstrated the relationship between Inferior Vena Cava (IVC) diameter and several physical attributes, including height, weight, and abdominal girth. Our results indicated significant positive correlations between IVC diameters and these bodily measurements. These correlations create a crucial benchmark for IVC, enabling its use in evaluating and anticipating dehydration severity. The established reference ranges may also contribute to the formulation of additional equations. To improve precision and relevance, subsequent studies should determine standard values using larger populations, investigating the connections between these measurements and additional variables, to optimize IVC diameter calculations across different age ranges and physical characteristics.

Conflict of Interest: Nil

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