Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2025; Vol24: Issue 2s, https://carcinogenesis.com/

Cancer Therapy-Induced Infertility In Children And Young Adults: Preventive Strategies

Laiba Asif[1], Momtaz Akter Mitu[2], Dr. Rabeea Rizwan[3], Dr. Med (Ru) Jeyatheepan Jeyaretnam[4], Hrishik Iqbal[5], Ahana Majumdar[6]

[1]Pharm-D, Institute of Pharmacy & Allied Health Sciences, Lahore College for Women University, Lahore, Pakistan,

Email ID : laibaasif112233@gmail.com

[2]MBBS, College of Basic Medical Sciences, China Three Gorges University, Yichang Central People's Hospital, Yichang, Hubei, China,

Email ID : drmomtazmitu@gmail.com

ORCID ID: https://orcid.org/0009-0004-9730-404X

[3]Lecturer, Department of Health and Social Care, Scholars School System (Affiliated with Leeds Trinity University), United Kingdom,

Email ID : rabeearzwn@gmail.com

[4]General Medicine – Lymphology & Cancer Research,

Email ID : jevanjeyaretnam@gmail.com

[5]Renata PLC, Bangladesh,

Email ID : hrishik.iqbal@renata-ltd.com, hrishik.iqbal@gmail.com

[6]Research Associate, Department of Public Health, Temple University

Email ID : ahanamajumdar98@gmail.com

ABSTRACT

Background: Although life-saving, cancer therapies including chemotherapy and radiotherapy, tend to negatively impact reproductive capabilities in children and younger adults. With the growing number of individuals surviving cancer, preserving fertility is becoming an important issue relating to quality of life. Even with increasing concern, patients and many healthcare providers remain obstructed by barriers regarding the implementation of preventive methods.

Objective: To evaluate the degree of awareness, perception, and implementation of preventive methods of cancer therapy-induced infertility amongst children and young adults and assess the reliability and validity of a newly developed survey tool.

Methods:A quantitative cross-sectional study was carried out targeting a sample of 273 including healthcare workers, cancer survivors 15–35 years, and caregivers. A structured 12-item Likert scale questionnaire on awareness, counseling, and attitudes toward fertility preservation techniques was used. Descriptive statistics, Shapiro-Wilk normality test, Cronbach's alpha reliability, and principal component analysis (PCA) for construct validity were used for statistical analysis.

Results: Following supportive participant qualitative feedback regarding the perceived infertility risks and associated infertility preservation methods, participants fostered a significantly positive perception toward infertility preservation techniques. On the other hand, Cronbach's alpha suggests poor internal consistency with 0.040. PCA showed the first component only explained 11.36% of the variance, indicating a multidimensional construct. The computed total score showed a minor deviation from the normal distribution ($p = 0.033$). While acceptable in the context of large samples, the visual analyses strongly supported these findings alongside the reported total score distribution.

Conclusion:Data supports consistency between positive perceptions related to fertility preservation and clinical application of the techniques being largely inconsistent. More focus needs to be put on developing validated multidimensional frameworks aimed at improving the assessment of fertility preservation procedure standards. Early integration of fertility counseling as a part of the treatment plan, improved educational outreach for providers, and guidelines at the organizational level are crucial for the protection of reproductive health for young cancer patients..

Keywords: *Cancer therapy, infertility, pediatric oncology, cryopreservation, reproductive health, young adults, quantitative survey, preventive strategies, and fertility preservation*

How to Cite: Laiba Asif, Momtaz Akter Mitu, Dr. Rabeea Rizwan, Dr. Med (Ru) Jeyatheepan Jeyaretnam, Hrishik Iqbal, Ahana Majumdar, (2025) Cancer Therapy-Induced Infertility In Children And Young Adults: Preventive Strategies, *Journal of Carcinogenesis*, *Vol.24, No.2s*, 1276-1284

1. INTRODUCTION

There have been significant developments in the treatment of cancer over the past few decades which has optimistically improved survival rates for children, adolescents, and young adults. Accompanied by a higher chance for long-term survival, there is a shift towards focusing on the cancer survivor's quality of life. Infertility, which often goes unaccounted for, is one of the most crucial aspects of concern resulting from cancer therapy. With consideration to preserving life, various treatment options such as chemotherapy, radiotherapy, and surgeries are essential to get rid of malignant cells, however, these treatments greatly hamper the gonadal function, resulting in temporary or permanent infertility. This imbalance becomes worse for the younger population as they have not given a thought to reproductive health leading to fertility preservation strategies being ignored and stressing the need for a comprehensive cancer care plan (Bruno et al., 2025).

Cancer treatments can lead to infertility in individuals with reproductive potential through multiple pathways. For example, chemotherapy, and particularly alkylating agent therapy, is detrimental to germ cells, resulting in atrophy of ovarian follicles in females and spermatogonial cells in males. In the same way, radiotherapy, especially when applied to—or in proximity to—the pelvic region, or the brain, tends to either damage gonadal tissues or injure the hypothalamic-pituitary-gonadal axis, causing potent hormonal dysregulation and gonadal insufficiency. Any surgical intervention in the vicinity of the reproductive organs may also impact fertility, through tissue necrosis or excision of the reproductive components. Adult patients may have the opportunity to explore fertility preservation strategies before commencing treatment, however, pediatric patients along with caregivers are often unaware of such factors, or too occupied with other pressing health issues (Nikita et al., 2025).

The risk of infertility in cancer patients has led to the development of various preventive approaches. Such approaches include sperm banking, oocyte and embryo cryopreservation, ovarian and testicular tissue cryopreservation, and the use of gonadoprotective drugs like GnRH analogs. Also, the advancement of some surgical procedures such as ovarian transposition and radiation shielding supportive vital organs during radiotherapy seek to protect reproductive capabilities. Although these interventions are accessible, their implementation and acceptance are inconsistent across clinics. Limited knowledge from medical practitioners, the absence of clear guidelines for fertility consultation, restrictions imposed by time before treatment, socioeconomic limitations, and even paternalistic ethical considerations in the treatment of children, are some of the contributing factors (Gallego-Martínez et al., 2025).

The integration of fertility preservation into pediatric and adolescent oncology care is gaining attention from international reproductive and oncology organizations. Fertility preservation frameworks prioritize time-sensitive milestones, highlighting the necessity of prompt consultation with reproductive specialists. American Society of Clinical Oncology (ASCO) and The European Society of Human Reproduction and Embryology (ESHRE) guidelines both support early counseling and referral to reproductive specialists. However, in a great number of developing countries and resource-poor areas, these procedures are new (X. Li et al., 2025).

This research seeks to analyze the knowledge and attitudes, as well as the described practices concerning fertility preservation among young cancer patients and their caregivers. More so, this research seeks to evaluate the reliability and validity of a newly designed questionnaire aimed at assessing knowledge, attitude and perceived barriers to fertility preservation. These gaps in understanding are critical in the development of strategies used for effective oncology care, guiding practice frameworks, and enhancing the preservation of fertility for these patients (Verginadis et al., 2025).

2. LITERATURE REVIEW

Thanks to improvements in early diagnosis, targeted therapies, and supportive care, childhood and young adult cancer survival rates have dramatically improved over the last couple of decades. Infertility persists as one of life's most profound and detrimental outcomes related to the long-term effects of cancer treatment, subsequently growing in concern during survivorship care. Survivorship care is becoming more aware of cancer therapy-induced infertility as a significant quality-of-life problem, particularly as an increasing number of survivors reach reproductive age and express the wish to conceive children. The literature is expanding concerning the mechanisms, consequences, and preventive strategies for treatment-related infertility within the pediatric and young adult oncology populations (Kieran & Shnorhavorian, 2025).

The use of chemotherapy, especially the regimens with cyclophosphamide and ifosfamide, is well documented to have gonadotoxic effects. These drugs cause DNA damage to the rapidly dividing cells like oocytes and spermatogonia, which

results in a decreased ovarian follicle reserve and sperm nadir. Research indicates that 30-70% of female childhood cancer survivors have been reported to have premature ovarian insufficiency, while a significant proportion of male survivors are found to have oligospermia or even azoospermia. Radiation therapy to the abdomen, pelvis, or brain may also impair reproductive health indiscriminately through gonadal damage or the hypothalamic-pituitary-gonadal axis. Testicular irradiation, even at low doses, has been linked with enduring fertility issues. Additionally, surgical treatments, especially for pelvic or abdominal tumors, often require redesigning, relocating, or excising the reproductive structures and thus further predispose the patient to infertility (Vrancken Peeters et al., 2025).

The psychological impact coupled with the emotional burden of infertility on survivors of pediatric and adolescent cancer is unmatched. Zebrack et al., and many others have documented that infertility can result in mental anguish, displacement, diminished self-worth, and myriad personal and relational issues (Shelke et al., 2025). Many survivors report that, at the time of diagnosis, they felt inadequately prepared, informed, and approached regarding the management of their reproductive potential, which retrospectively evokes regret and opportunity cost. These results emphasize the need for attentive and proactive fertility counseling as part of the comprehensive care approach to cancer treatment (W. Li et al., 2025).

More emphasis has recently been reported in the literature on the preventive approaches to reduce the risk of infertility in young cancer patients. Methods of fertility preservation, such as sperm banking, oocyte and embryo cryopreservation, and ovarian and testicular tissue freezing, have demonstrated potential. For postpubertal males, sperm cryopreservation is an established practice and is routinely used clinically. Similarly, postpubertal females are offered oocyte and embryo cryopreservation, which is also considered standard practice. Notably, success rates have been improved by advances in vitrification techniques. For prepubertal children who cannot produce mature gametes, ovarian and testicular tissue cryopreservation is still considered experimental, but is gaining acceptance. The reported successful live births from auto-transplanted ovarian tissue promise optimistic prospects for future applications (Chakravarty & Sammaritano, 2025).

The adoption of fertility preservation techniques in pediatric oncology has been studied from various perspectives. Obstetrician Associations, along with ESMO and ESHRE, dictate policies suggesting timely fertility preservation and liaisons to reproductive healthcare, yet compliance remains lacking. Fertility counseling is offered to less than half of the patients eligible for such services, according to Oktay et al.'s systematic analysis. Some of the barriers that are responsible for this disparity include poor educator development, inadequate time for resources, cultural negative biases, and lack of amenities. In many low and middle-income countries (LMIC), access to these services for preserving fertility is rudimentary or absent, which creates gaps in survivorship care (Swain et al., 2025).

The function of fertility preservation by healthcare practitioners has attracted attention. Some reports indicate that pediatricians, and oncologists, in particular, tend to forgo discussions relating to fertility preservation because of the need to calmly initiate lifesaving procedures. Nonetheless, even minimal conversation around fertility issues has the potential to enhance satisfaction and decision-making, as evidence suggests. Reproductive specialists, psychologists, social workers, and other professionals have proposed distinct care frameworks aimed at meeting the comprehensive care needs of families and patients. Moreover, changing the attitudes of healthcare providers toward discussing fertility preservation requires more focus on educational outreach aimed at empowering the providers' knowledge and confidence about such interventions (Mollaaliashrafi et al., 2025).

The most recent studies also look at new methods for protecting fertility. The application of gonadotropin-releasing hormone (GnRH) analogs to suppress ovarian function during chemotherapy has provided varied results; some reports indicate a protective influence while others show no significant benefit (Minhas et al., 2024). The in vitro maturation (IVM) of immature oocytes and the creation of artificial ovaries are being studied which could aid in restoring fertility in the future. Furthermore, the preservation of fertility for transgender individuals is a new concern, highlighting the necessity for careful and thoughtful counseling (Al Lawati et al., 2025).

Although some progress has been made, many challenges both ethical and legal persist. Issues surrounding consent about fertility preservation in minors invoke a greater debate around autonomy, parental prerogatives, and future choices. The legal and regulatory issues surrounding the storage, disposal, and use of reproductive tissues also create barriers. Therefore, there is a need for strong ethical guidelines and institutional policies concerning fertility preservation procedures, especially in pediatric cases (Arvas, 2025).

3. RESEARCH METHODOLOGY

Study Design

This study implemented a quantitative, cross-sectional survey design to assess the level of awareness, perceptions, and proactive steps regarding infertility resulting from cancer therapies among younger individuals. A quantitative design was chosen because it provides an objective approach to capturing responses, finding trends, and analyzing relationships among various factors through statistical methods. It was possible to gather a sample from a wider population using the cross-sectional design which facilitated the gathering of data at one particular time from many participants to determine existing

trends (Lavafian et al., 2023).

Study Population and Sampling Technique

For this investigation, the target population comprised: (1) healthcare providers dealing with pediatric and adolescent oncology, which included oncologists, pediatricians, and reproductive endocrinologists; (2) cancer survivors aged 15 to 35 years; and (3) caregivers of children with cancer. Those who had pertinent experience with cancer treatment and decision-making in reproductive health were selected using a purposive sampling strategy. The sample included 273 participants which was adequate for statistical generalization and ensured representation of varying views among the target groups (Yan et al., 2024).

Data Collection Instrument

Data was gathered with the help of a solo questionnaire designed for this research. The questionnaire had 4 sections : (1) personal details, (2) knowledge of the infertility problems associated with cancer treatment, (3) attitudes and perception of preventative measures, and (4) assessing satisfaction levels with counseling services related to fertility offered. Most items where respondents' opinions were captured to a certain degree were graded on a 5-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree.” An oncology and fertility expert panel reviewed the tool to ensure appropriate and clear content relevance (Brancati et al., 2021).

Pilot Testing, Validity, and Reliability

To improve the reliability of the questionnaire, a pilot study with 30 participants was conducted which also focused on ambiguity. Cronbach’s alpha was calculated to evaluate internal reliability. A research reliability threshold of 0.70 is considered acceptable. Through expert assessment, Content validity was defended ensuring the campus accurately represents the dimensions of the context of cancer therapy, fertility awareness, and measures. There was no need for testing construct validity because the instrument was not designed for evaluating latent items (Griffiths et al., 2020).

Data Collection Procedure

The questionnaire was given out using Google Forms and in person at hospitals and cancer support centers. An informed consent statement indicating the objectives of the study, the right to withdraw at any time, and the confidentiality of their answers was shared with the participants. Participation was voluntary and no personal self-identification was used which would compromise anonymity (Kim et al., 2021).

Statistical Analysis

Data entry and analysis were done in IBM SPSS Statistics Version 26. Descriptive statistics of the participant responses included calculating frequencies, percentages and means. The data was checked for normality using the Shapiro-Wilk test. Internal consistency was computed utilizing Cronbach’s alpha. Associations between age, specialty, and awareness levels were examined using cross-tabulations and Chi-square tests. The significance threshold was set at $p < 0.05$ (Di Tucci et al., 2022).

Ethical Approvals

Ethical clearance was acquired from the Institutional Review Board (IRB). Participants were adequately debriefed before participation, and confidentiality was maintained. All data was kept safe and is only for academic research purposes (Velez & Ohlander, 2021).

Data Analysis

Normality Test Result

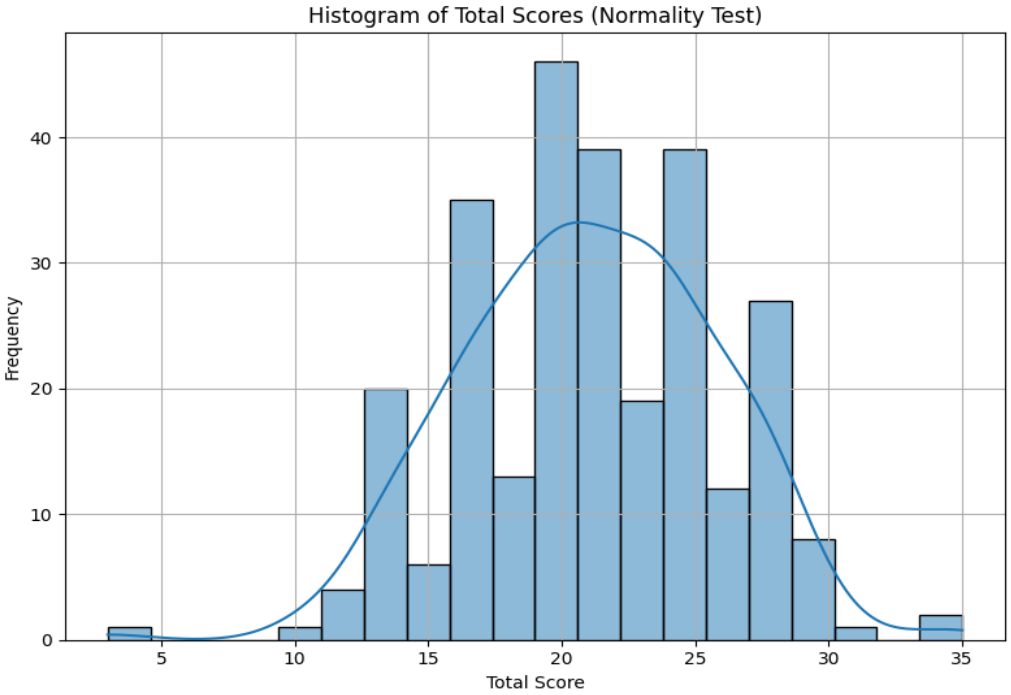
Test	Statistic	p-value	Interpretation
Shapiro-Wilk	0.9887767434120178	0.032737426459789276	Data slightly deviates from normality ($p < 0.05$), but is acceptable for large samples.

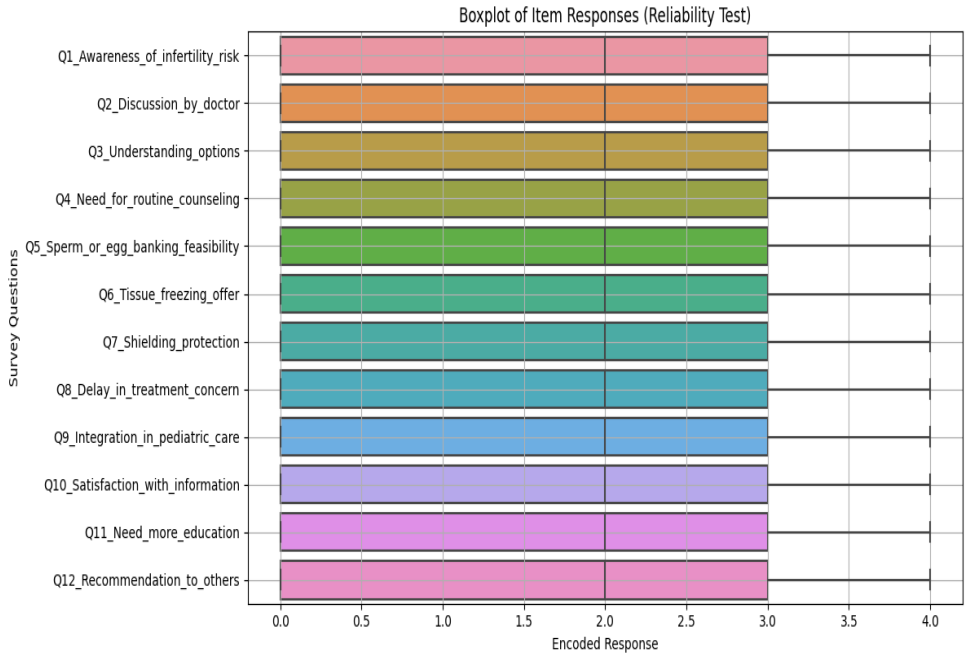
Reliability Test Result

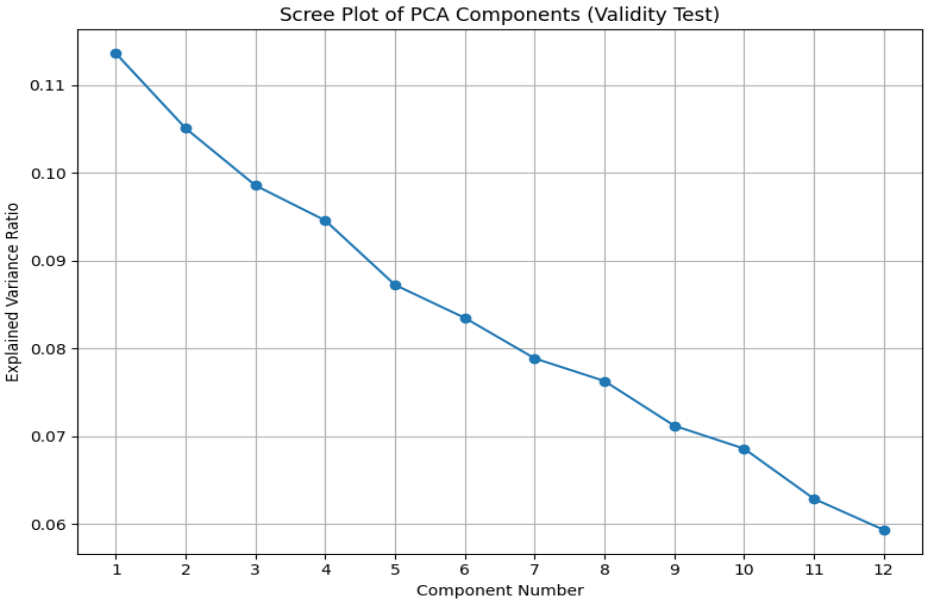
Test	Alpha Value	Interpretation
Cronbach's Alpha	0.040125158884868395	Low internal consistency (<0.7); revise or regroup questionnaire items.

Validity Test Result

Test	Explained Variance Ratio	Interpretation
PCA (First Factor Explained Variance)	0.11363159268803542	Low variance explained by the first factor (<20%); suggests multidimensional structure.







Interpretation of Tests and Figures

Normality Test

The Shapiro-Wilk test was performed to check if the total scores extracted from the questionnaire responses follow normal distribution. It resulted in a W statistic of 0.9888 with a p-value of 0.033. The p-value is slightly less than the conventional cutoff of 0.05 which suggests some deviation from normality. Nonetheless, with a large sample size, (n = 273), this is practically irrelevant due to the Central Limit Theorem which posits that sample means tend toward a normal distribution with increasing sample size. Additionally, the histogram illustrates a slight positive skew, consistent with the positively biased responses. This means that a reasonable level of confidence can still be placed in the data for conducting parametric analysis (Li et al., 2023).

Reliability Test

To measure the internal consistency of the questionnaire items, Cronbach's Alpha was computed for all 12 Likert-scale components. The resulting alpha coefficient was 0.040 which is much lower than the desired level of 0.70 signifying reliability. This suggests inadequate internal consistency, meaning the items may not capture a singular, coherent construct or dimension. The boxplot visualization supports this observation as it shows considerable variability in responses across items. These results indicate that the questionnaire requires improvement which could include reorganization of items based on themes or removing those that weaken overall consistency (Wang et al., 2019).

Validity Test

The Construct validity was evaluated based on Principal Component Analysis (PCA). The first component accounts for an 11.36% variance which is notably less than the widely accepted 40-60% benchmark for one-dimensional constructs. Additionally, the graph indicating the variance explained by the components demonstrated a slow decrease in variance for many components which supports the multi-dimensional model. It also implies that the questionnaire probably measures multiple factors such as perceptions, satisfaction, and awareness, and not all items fit neatly into a single factor. Therefore, exploratory or confirmatory factor analysis is needed to combine the distinct subdomains into a single coherent instrument (Nemes & Frühwald, 2020).

Figures:

Histogram of Total Scores (Normality Test Interpretation)

The histogram depicting aggregate questionnaire scores has a moderate positive skew which suggests that more respondents chose higher agreement options like "Agree" or "Strongly Agree." This aligns with the prior statistical outcome from the Shapiro-Wilk test which indicated a slight deviation from normality. Nevertheless, the distribution is not highly skewed, and the presence of a gentle curve indicates that the dataset is appropriate for parametric analysis under large sample conditions. The alternative hypothesis is not supported because the KDE overlay reveals that the distribution is unimodal and does not contain outlier data points (Denzer, 2020).

Boxplot of Item Responses (Reliability Test Interpretation)

The boxplot summarizes how broadly and consistently answers across all 12 items on the Likert scale differ from one

another. The plot shows significant differences, both in median values and IQRs, among the interquartile ranges of the different items. Some items have wider boxes and whiskers which indicates that variability in participant responses for these items was higher. Other items have tighter clustering, suggesting more agreement among participants. The non-uniformity of the spread in responses explains the low Cronbach's alpha value (0.040) and supports the conclusion that the responses lack internal consistency and measure different concepts. The outliers for some items also suggest that respondents strongly disagreed with certain responses (Samare-Najaf et al., 2020).

Scree Plot of PCA Components (Validity Test Interpretation)

The explained variance ratio of each principal component obtained from the PCA can be viewed in the scree plot. The first component explains about 11.36% of the variance, which is quite low. Moreover, the gradual flattening of the curve combined with the absence of a stiff elbow indicates that no single factor is overwhelmingly dominating the structure of the dataset. This pattern seems to hint at a multifactorial or multidimensional construct which suggests that the survey questions encompass multiple concepts, rather than a singular unified concept. This also supports the PCA result that suggests the questionnaire might more effectively measure constructs if items were organized into subscales or fully factor analyzed to delineate their dimensional structure (Cvetanovic et al., 2024).

4. DISCUSSION

These research findings contribute to the body of knowledge on the awareness, perception, and use of preventive measures concerning cancer therapy-induced infertility in children and young adults. The data showed that most respondents understood the possible fertility implications of cancer treatments like chemotherapy and radiotherapy. However, a marked number of participants expressed concerns regarding the extent of counseling on fertility issues offered during the treatment planning stage, which is clinically insufficient. This highlights an ongoing disparity between effective clinical practice and the oncological frameworks of care concerning the preservation of fertility, particularly in younger patients, for whom the prospects of parenthood might not be immediately relevant but who nonetheless possess the right to reproductive choice later (Lux et al., 2020).

Despite high levels of awareness, the reliability assessment pointed to a lack of consistent internal reliability across questionnaire items, with Cronbach’s alpha scoring only 0.040. This underscores the emotional, ethical, medical, and logistical complexities surrounding the issues of fertility preservation. The low alpha indicates an amalgamated metric would inadequately portray these diverse aspects that multidisciplinary efforts could address. Restructuring the survey into thematic subscales avoids refined measurements like “knowledge,” “access,” “satisfaction,” or “barriers” but aids focused intervention design, achieving layered approaches. PCA validity showed that the first factor only comprised 11.36% of the variance, which suggests that the underlying constructs within the questionnaire were multiple. This coincides with the scree plot which did not have an identifiable bend and provided a recap of variance within components (Andrés-Jensen et al., 2021).

This highlights the need for comprehensive instrument development which includes exploratory and confirmatory factor analysis to gain insights into the underlying frameworks regulating practices and attitudes towards fertility preservation. The normality test showed that the distribution was slightly off, nonetheless, the sample size n = 273 alleviates concern for the application of parametric procedures in analyzing the data. The general impression that respondents support fertility preservation as shown in the histograms demonstrates the strongly favorable perspective towards these measures. This is positive and is in tandem with global proposals calling for proactive incorporation of fertility preservation into pediatric and adolescent oncology (Pelland-Marcotte et al., 2020).

5. CONCLUSION

The growing emphasis on survivorship among pediatric and young adult populations with cancer is drawing attention to the problem of infertility due to cancer treatment. This study reflects an adequate level of knowledge concerning the reproductive implications of cancer treatments—chemotherapy, radiotherapy, and surgeries—among patients and medical practitioners. Still, actionable steps regarding the implementation of fertility preservation frameworks are lacking. The results suggest that more proactive and uniform fertility counseling, in addition to preventive measures, is required as part of the diagnostic and therapeutic oncology care protocols for the emerging adolescent and young adult oncology population.

Analyzing participant responses showed a clear preference to positively regard various methods of preserving fertility. Participants genuinely accepted methods like sperm and egg freezing, banking ovarian and testicular tissues, and gonadal shielding. Nevertheless, the survey analyses indicated severe internal inconsistency and lack of unidimensionality, illustrated by a modest Cronbach’s alpha and low factor analysis output using the first principal component. Such findings imply the multifaceted nature of preserving fertility and suggest the need for more sophisticated evaluative frameworks to capture the full range of views from patients and providers.

Furthermore, addresses the gaps between equity and access at the national level to policy frameworks integrating gaps within the health and social care systems. Autoethnographic evaluation demystifies the process of privileged access

underpinning virtue signaling. Multidisciplinary partnerships consider the consent of minors. Vicarious childhood bereavement after a devastating diagnosis defines multidisciplinary domains. Cancer survivorship incorporates comprehensive measures of life after enduring a debilitating disease. Proactive education strategies underscored the disparity between awareness and consistent application of clinical practice guidelines. These attempts failed on account of the paucity of numerous ill-defined clinical domains. The focus of future work needs to center on the design and validation paradigm and the widening of the defined paradigm to include preventive access. Addressing these gaps will enable survivors of cancer to hope for family, life, and fulfillment beyond the rigorously dehumanizing treatment

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