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Preliminary assessment of the Healthy Early Life Moments (HELMS) webinars in empowering Developmental Origins of Health and Disease (DOHaD) concept among healthcare professionals – a pragmatic serial cross-sectional study

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Abstract

Objectives: The Developmental Origins of Health and Disease (DOHaD) concept has gained prominence in maternal and child health (MCH), emphasizing how early-life factors impact later-life non-communicable diseases. However, a knowledge–practice gap exists in applying DOHaD principles among healthcare professionals. Healthy Early Life Moments in Singapore (HELMS) introduced webinars to bridge this gap and empower healthcare professionals. We aimed to conduct a preliminary assessment to gain early insights into the outreach and effectiveness of the educational initiative offered with the HELMS webinars.

Methods: We employed a pragmatic serial cross-sectional study approach and targeted healthcare professionals involved in MCH care. We also collected and analyzed data on webinar registration and attendance, participants' profession and organizational affiliations, and post-webinar survey responses.

Results: The median webinar attendance rate was 59.6 % (25th–75th percentile: 58.4–60.8 %). Nurses represented 68.6 % of attendees (n=2,589 out of 3,774). Post-webinar surveys revealed over 75 % of the participants providing positive responses to 14 out of 15 survey questions concerning content, delivery, applicability to work, and organization.

Conclusions: Assessment of the HELMS webinars provided insight into the outreach and early effectiveness in enhancing healthcare professionals' knowledge and confidence in delivering DOHaD education. Bridging the knowledge–practice gap remains a crucial goal.

Keywords: Developmental Origins of Health and Disease; maternal and child health; webinars; survey; cross-sectional study

Chee Wai Ku and Roderica R.G. Ng contributed equally to this work and share joint first authorship.

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Introduction

Maternal and child health (MCH) has undergone a significant transformation with the emergence of the Developmental Origins of Health and Disease (DOHaD) concept. This paradigm shift sheds light on the profound impact of early factors, spanning the pre-pregnancy to perinatal period [1, 2], on subsequent non-communicable diseases [3–6]. Therefore, there is a crucial need for healthcare professionals to comprehensively grasp and adeptly deliver DOHaD education to women.

The resonance of DOHaD extends beyond research and healthcare, particularly resonating with mothers [7]. Illustrated by a Canadian survey, increased DOHaD knowledge positively influenced pregnant women's motivation and self-efficacy, leading to improvements in their diet quality [8]. Moreover, medical schools and international organizations are championing recommendations and educational initiatives to guide the public in embracing this life-course perspective [9–12]. Initiatives like England's annual reporting focus on vigilant monitoring and enhanced preconception healthcare interventions [13]. Collectively, these efforts signify the commencement of a transformative evolution in DOHaD understanding and practice.

However, the current landscape reveals disparities in DOHaD knowledge levels among healthcare professionals of different specialties [14]. For instance, in Japan, where undergraduate nutrition students undergo four years of DOHaD education, awareness only peaked at 70 % [9]. Similarly, in New Zealand, despite three years of DOHaD education for undergraduate nursing students, the maximum awareness reached was only 60 % [9]. An Australian survey targeting healthcare professionals highlighted limited self-efficacy and knowledge gaps in DOHaD, hindering its integration into clinical practice [15].

The healthcare system in Singapore, renowned for its efficiency and seamless integration of public and private sectors, has established a robust framework for MCH. Despite these strengths, there is a historical emphasis on antenatal care at the expense of preconception and postpartum care. This imbalance is compounded by a significant knowledge–practice gap due to the absence of standardized clinical guidelines for DOHaD counseling [16]. This gap is particularly evident in a recent local study evaluating the knowledge, attitudes, and practices (KAP) of medical students, Obstetrics and Gynecology (O&G) residents, and Pediatrics residents [17]. The results underscore the pressing need to extend educational efforts beyond obstetricians, encompassing general practitioners and allied healthcare professionals who play pivotal roles in influencing women's early life environments.

Unfortunately, the primary source of DOHaD education remains academic literature and conferences, with inadequate translation to practical application via structured DOHaD educational programs [14]. In response to these identified gaps, KK Women's and Children's Hospital (KKH) launched the Healthy Early Life Moments in Singapore (HELMS) initiative [16] – a comprehensive framework aimed at improving the health of mothers and children using a life-course approach (Figure 1). As part of HELMS, a series of practice-oriented webinars was initiated to bridge the knowledge–practice gap, equipping healthcare professionals with the knowledge and confidence to deliver DOHaD education effectively. This initiative leveraged webinars as an efficient, flexible, and cost-effective educational medium [18–21], offering a proactive response to the evolving landscape of medical education, particularly in the context of the COVID-19 pandemic. Importantly, evidence suggests that internet-based continuing medical education programs not only match traditional face-to-face formats in knowledge dissemination [22] but also contribute to tangible changes in clinical practice [23].

In this study, we aimed to conduct a preliminary assessment via post-webinar surveys to gain early insights into the outreach and effectiveness of the educational initiative offered with the HELMS webinars. We employed a pragmatic serial cross-sectional study approach which allowed us to capture multiple snapshots of the current situation and assess the immediate impact of our educational efforts.

Our study's findings will guide improvements in subsequent webinar series, enhancing content delivery, engagement, and relevance to the target audience. Through the strategic utilization of real-world data and experiences, our overarching objective is to provide actionable insights that pave the way for effective strategies in DOHaD and MCH education, hence fostering continuous improvement and excellence in the understanding and application of DOHaD principles in daily clinical practice. The goal is to positively influence long-term MCH outcomes on a population-wide scale, thereby contributing to a healthier and more resilient future generation.

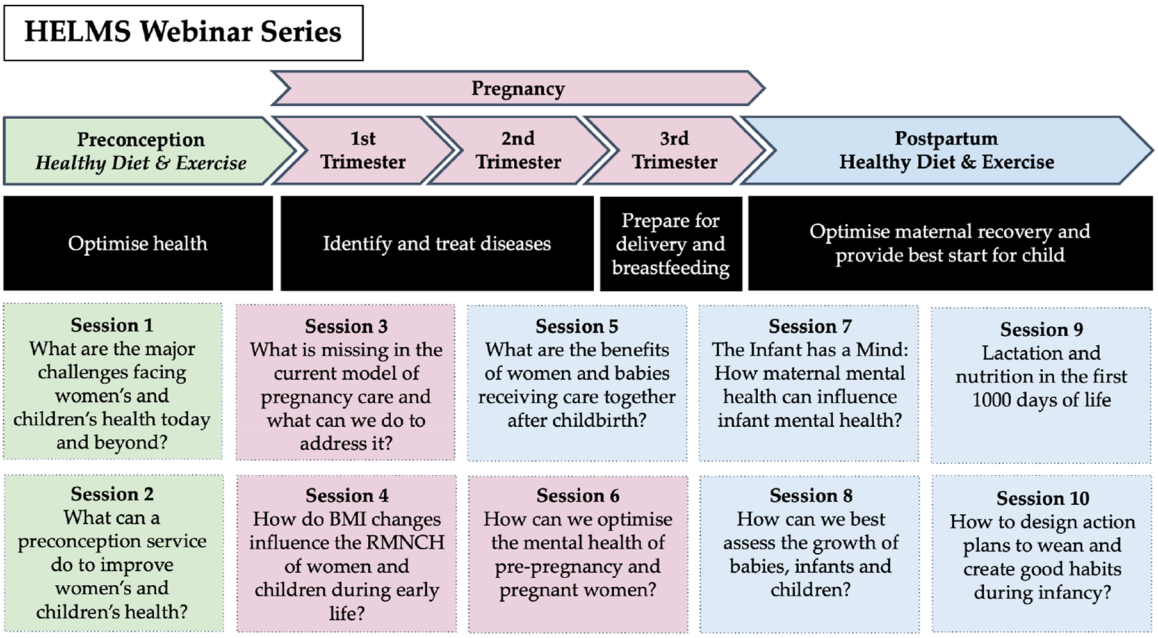

Figure 1: Framework and monthly topics of the HELMS webinar series (January to October 2022) are rooted in the Developmental Origins of Health and Disease (DOHaD) and the life-course transgenerational impact. Sessions 1 and 2 cover preconception-related topics, while Sessions 3, 4, and 6 focus on pregnancy, and Sessions 5, 7–10 address postpartum-related topics. The deliberate focus on preconception and postpartum aims to address gaps in current clinical care practices.

Materials and methods

Study design

This was a pragmatic serial cross-sectional study which aimed to gain early insights into the outreach and effectiveness of the HELMS webinars via optional post-webinar surveys.

Ethics approval and written informed consent

Ethical approval and written informed consent were not required for this study as unidentified data was used and anonymous post-webinar surveys were administered.

Target participants

The primary target participants for the study were a diverse group of healthcare professionals engaged in MCH delivery in Singapore. This group encompassed doctors, nurses, and allied health professionals from both primary and tertiary care settings. It is noteworthy that no exclusion criteria were implemented, facilitating a comprehensive inclusion of healthcare professionals and ensuring representation from various sectors of MCH delivery. This deliberate approach aimed to provide a holistic perspective on DOHaD education across different healthcare settings in Singapore.

In the primary care setting, we invited healthcare professionals from all three healthcare clusters nationwide: SingHealth Polyclinics (SHP), National Healthcare Group Polyclinics (NHGP), and National University Polyclinics (NUP). Polyclinics, integral to the public healthcare system, collectively contribute to 20 % of Singapore's primary healthcare system [24]. In addition, the study actively engaged general practitioners (GPs) associated with the Primary Care Network (PCN), which constitutes 25 % of Singapore's primary healthcare [25].

In the tertiary care setting, practitioners from KKH, Singapore's largest specialist tertiary center for obstetrics and gynecology, were also included [26]. KKH handles approximately one-third of all deliveries in Singapore [26]. Furthermore, specialists affiliated with private hospitals were also among the target participants.

Outreach strategy

Publicity for the webinar series leveraged a digital approach to optimize outreach and engagement. The HELMS team meticulously crafted and disseminated publicity emails across primary and tertiary healthcare institutions. These emails included detailed information about the engaging content of the webinars along with registration links. To enhance awareness and participation, a structured email schedule was implemented, involving four emails sent at strategic intervals before each webinar: 1 month before, 2 weeks before, 1 week before, and 1 day before the scheduled event. This systematic approach aimed to provide timely and consistent reminders to potential participants. Registration remained open throughout the series, ensuring continuous accessibility for interested healthcare professionals.

Design and implementation of webinars

The webinar series, comprising 10 monthly sessions running from January 2022 to October 2022, was meticulously designed to explore topics rooted in DOHaD and the life-course transgenerational impact.

These sessions offered a comprehensive journey, starting from preconception topics in the early webinars to postpartum topics in the later sessions. The focus of each session was extended to address the challenges of the rising metabolic and mental health pandemic.

These concise, one-hour sessions, strategically held during Friday lunchtimes, aimed to accommodate the demanding schedules of primary care providers. Hosted on the Zoom platform, each session featured expert physicians specializing in MCH and was conducted live to encourage real-time participant interaction and engagement through online Q&A. Importantly, these domain experts undertook contemporary literature reviews for each session, ensuring the delivery of pragmatic and up-to-date information for healthcare professionals.

The selection of topics was participant-driven, identified through a poll conducted during the inaugural webinar. These topics were carefully aligned with the HELMS objectives, encompassing a broad spectrum of themes such as mental health optimization across various stages of women's lives, the impact of body mass index on women and children's health, and the promotion of nutrition and healthy habits in infancy, as illustrated in Figure 1.

Assessment of webinars' outreach with attendance and participant profiling

We evaluated the webinar outreach based on attendance rates and the profiling of attendees. Attendance was monitored by recording the highest total number of participants visible on the Zoom platform for each session. The attendee lists for the webinars were compiled using Zoom's attendance reports, allowing us to gain insights into the participants' professions and organizational affiliations with the matching of registration information.

Assessment of webinars' effectiveness with a 15-question post-webinar survey

To assess the effectiveness of each webinar, participants were directed to an anonymous, optional post-webinar survey, hosted on the Zoom platform, after each session. This survey comprised 15 questions structured on a 3-point Likert scale format (Agree, Neutral, Disagree). The questions covered participants' understanding and relevance of the webinar contents to their work, evaluation of the presentation and content, assessment of the Q&A session and its organization, as well as considerations for future participation and recommendations.

Statistical analyses

Simple descriptive statistics were used to analyze our data. Mean±-standard deviation or median (inter-quartile range) were used to describe normally distributed and skewed continuous variables respectively. Skewed data, determined by histogram plots and a skew value of <−0.5 or >0.5, were presented as median with its 25th and 75th percentile values. Categorical variables were described using frequencies (percentages).

Attendance rates were calculated by dividing the number of attendees by the total number of registrations for each monthly webinar session, providing a gauge of the proportion of registrants actively participating. A visual comparison of month-on-month attendance rates using a combined bar and line chart (Figure 2) was done to identify variations or patterns, offering insights into participant engagement dynamics.

Further analysis was performed on attendee distribution based on profession (healthcare administrators, allied health professionals, doctors, and nurses) and organizational affiliation (primary or tertiary healthcare institutions) (Table 1).

Additionally, we assessed the overall distribution of responses to the 15 questions in the post-webinar surveys, offering insights into the effectiveness of delivering DOHaD concepts through this HELMS webinar series (Table 2).

All statistical analyses were conducted using R software (version 4.3.1, Vienna, Austria).

Results

Attendance rate of webinars

During the 10-month webinar series, our median attendance rate was 59.6 % (25th–75th percentiles: 58.4–60.8 %) (Figure 2). Each session had a median absolute attendance of 358 participants, ranging from 312 (July) to 550 (May).

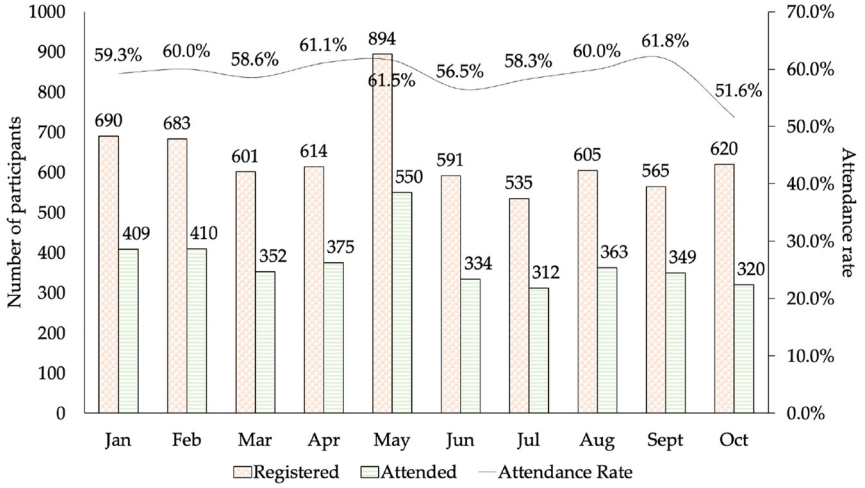

Figure 2: Distribution of attendance rates and the absolute number of registered and attended participants for the Healthy Early Life Moments in Singapore (HELMS) webinars across the months in 2022. The attendance rate was consistently close to 60 % across all webinars. The most attended webinar, on the topic "Benefits of combined maternal and fetal care postpartum," took place in May 2022.

Table 1: Demographics of the webinar participants.

Demographic variables	Number of participants, % n=3,772
Profession	
Nurses	2,589 (68.6 %)
Doctors	659 (17.8 %)
Allied healthcare professionals	320 (8.5 %)
Administrators	106 (2.8 %)
Ancillary staff	98 (2.6 %)
Organizational affiliation	
Primary healthcare institutions	1,667 (44.2 %)
Tertiary healthcare institutions	1,519 (40.3 %)
Private healthcare organizations	586 (15.5 %)

Categorical variables were presented as frequency (percentage). Private healthcare organizations include private general practitioner clinics and private tertiary hospitals. The majority of participants consisted mainly of nurses and doctors, with healthcare professionals from public primary and tertiary healthcare institutions comprising the largest portion of the participant pool.

The highest attendance was recorded in May 2022 for the webinar addressing "Benefits of combined maternal and fetal care postpartum" (Figures 1 and 2).

Demographics of webinar participants

Among the 3,772 attendees, nurses formed the largest group, comprising over two-thirds (68.6 %) of the total. Doctors accounted for the second-largest group (17.5 %), followed by allied healthcare professionals (8.5 %), administrators (2.8 %), and ancillary staff (2.6 %) (Table 1).

Organizational affiliations of attendees were evenly distributed, comprising 44.2 % from primary healthcare institutions (i.e., polyclinics) and 40.3 % from tertiary healthcare institutions. The remaining 15.5 % represented various organizations, including private GP clinics and private hospitals (Table 1).

Post-webinar survey results

Our post-webinar surveys achieved a median response rate of 25.0 % (25th–75th percentiles: 24.0–25.6 %). Every survey question achieved a 100 % response rate, attributed to the mandatory designation of all survey answers. Participants were required to provide responses to every question for successful submission of the survey. Positive feedback was predominant, with over 75 % agreeing to 14 out of 15 survey questions (Table 2, Figure 3). The percentage of participants who disagreed with the statements in the post-webinar surveys remained consistently low, ranging from 0 % to 1.9 ± 2.7 % across these 14 questions. Notably, participants

Table 2: Overall post-webinar survey results.

No.	Survey questions	Agree	Neutral	Disagree
	Understanding and relevance of webinar contents			
1	I understand the HELMS concept	90.4 ± 3.0 %	9.5 ± 2.7 %	0.1 ± 0.4 %
2	The content was relevant to my work	81.5 ± 5.8 %	16.6 ± 7.2 %	1.9 ± 2.7 %
3	After the webinar, I have acquired more knowledge about the topic from the presentation	92.1 ± 3.2 %	7.8 ± 3.3 %	0.2 ± 0.4 %
4	I can apply the skills and knowledge to my work	77.9 ± 4.0 %	20.6 ± 3.1 %	1.5 ± 1.7 %
	Evaluation of presentation and content			
5	The presentation was crafted well	94.2 ± 2.1 %	5.6 ± 2.1 %	0.2 ± 0.4 %
6	I enjoyed the content shared during the presentation	93.5 ± 3.2 %	6.4 ± 3.2 %	0.2 ± 0.4 %
7	The length of the presentation was just right	89.9 ± 2.9 %	9.4 ± 3.0 %	0.7 ± 0.6 %
	Assessment of Q&A session and its organization			
8	The Q&A session added to the knowledge I acquired from the presentation	81.9 ± 7.3 %	18.1 ± 7.0 %	–
9	The Q&A session was organized well with Zoom	85.3 ± 5.9 %	14.7 ± 5.7 %	–
10	There was sufficient interaction with the presenter	76.1 ± 6.8 %	22.8 ± 6.4 %	1.1 ± 1.3 %
11	Overall, the webinar was well organized	94.9 ± 2.7 %	5.0 ± 2.6 %	0.1 ± 0.4 %
	Zoom platform			
12	Zoom is an effective platform to host the webinar	94.1 ± 3.6 %	5.9 ± 3.2 %	–
13	I would prefer to attend a physical webinar	32.5 ± 7.0 %	38.2 ± 4.4 %	29.3 ± 8.5 %
	Considerations for future participation			
14	I would like to see more of such content in webinars	88.5 ± 3.8 %	11.5 ± 3.9 %	–
15	I would recommend the HELMS webinar to my colleagues	92.6 ± 2.7 %	7.3 ± 2.7 %	0.1 ± 0.3 %

Continuous variables were presented as mean ± standard deviation. More than 75 % of survey respondents "Agree" with 14 out of 15 post-webinar survey questions. Question 13, regarding attending a physical webinar, elicited the most diverse response.

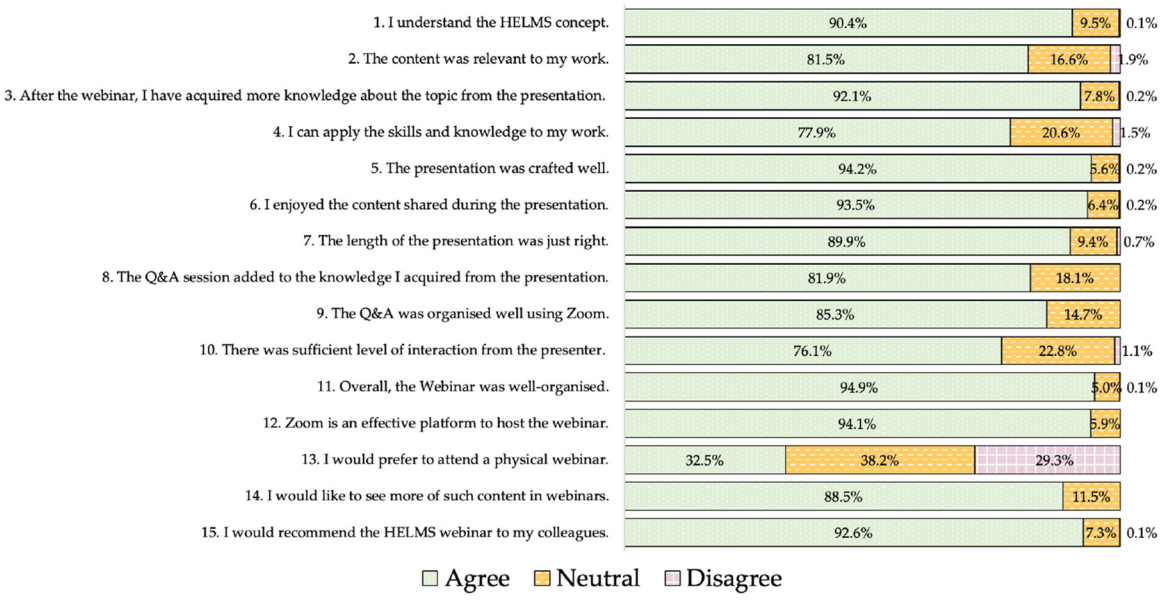

Figure 3: Overall post-webinar survey results demonstrate the distribution of responses to Agree, Neutral and Disagree. More than 75 % of survey respondents "Agree" with 14 out of 15 post-webinar survey questions. Question 13, regarding attending a physical webinar, elicited the most diverse response.

expressed varied opinions on the preference for physical webinars (Q13), with 32.5±7.0 % of participants agreeing, 38.2±4.4 % remaining neutral, and 29.3±8.5 % disagreeing to the statement.

Discussion

Based on the preliminary assessment of the HELMS webinars, our findings present encouraging results regarding the outreach and the immediate effectiveness of our educational efforts. The post-webinar surveys provided valuable insights into the engagement and empowerment of healthcare professionals with the knowledge and confidence to deliver DOHaD education to women, aligning with the aim of our HELMS webinars to bridge the knowledge–practice gap.

Enhanced DOHaD interest and willingness to learn among healthcare professionals

Traditionally, antenatal care has been the focal point in the MCH system [16], yet a burgeoning interest among healthcare professionals in understanding DOHaD principles and their practical applications in patient consultations has emerged. This surge of interest is corroborated by our relatively high attendance rates of the HELMS webinar, with a median of 59.6 %. It is worth noting that attendance rates at healthcare webinars have been reported to range from 23.9 to 60.2 % [21, 27, 28].

Our findings align with those of a recent local study conducted in Singapore, which investigated the KAP of obstetric and pediatric residents, along with medical students, regarding DOHaD. This study revealed a keen interest among healthcare professionals in bridging the knowledge–practice gap [17], as reflected in their participation in the webinar series. It is evident that there is a growing willingness among healthcare professionals to explore and implement DOHaD concepts in their daily clinical practice, marking an encouraging trend.

Nursing professionals play a key role in MCH

The data revealed a significant presence of nurses among webinar attendees, reflecting Singapore's healthcare staffing landscape, where nurses outnumber other healthcare disciplines [29]. This observation emphasizes the potential leadership role of nurses in spearheading initiatives aimed at advancing MCH care. Nurses are uniquely positioned as they spend substantial time with patients and play a key role in offering formal counseling and guidance on healthy lifestyle behaviors throughout the preconception, antenatal, and postpartum phases [24, 30].

Addressing the evolving healthcare landscape in Singapore

As Singapore's healthcare landscape undergoes a transformation, shifting from a predominantly tertiary hospital-focused model to one with a greater emphasis on primary and community care [31], a considerable portion of MCH services is expected to transition to community healthcare facilities. This shift accentuates the vital role of community and polyclinic nurses in MCH. By equipping these healthcare professionals with the necessary skills to counsel patients on DOHaD, we not only align with the changing healthcare environment but also contribute to the broader paradigm shift from a treatment-centric model led by doctors to a preventive-focused model led by nurses [32]. This transformative approach harmonizes with ongoing structural healthcare reforms [31] and holds the potential to drive significant behavioral changes in the population by prioritizing preventive care alongside treatment [32].

Effectiveness of HELMS webinar series

The consistent positive ratings of the HELMS webinar series, especially regarding content delivery and the applicability of skills learned, suggest the immediate effectiveness of our educational efforts in engaging and empowering a diverse group of healthcare professionals with the knowledge and confidence to deliver DOHaD education to women. However, it is crucial to acknowledge that this marks just one phase of our educational journey. While an impressive 90.4 % of participants expressed a solid understanding of the HELMS concept, there is room for improvement in terms of translating this knowledge into practical application, with 77.9 % agreeing that they can apply these skills and knowledge to their work. Bridging this knowledge–practice gap is essential [17] to ensuring self-efficacy among healthcare professionals in delivering effective DOHaD education and contributing to long-term MCH outcomes. Nonetheless, the initial findings provide a strong foundation for future educational initiatives, underscoring the potential for continued success in improving MCH through DOHaD education and highlighting the importance of ongoing efforts to bridge the knowledge–practice gap in clinical practice.

Webinars as an effective medium in medical education

Webinars have proven their effectiveness compared to asynchronous learning methods and traditional face-to-face classroom teaching, making them a widely embraced medium for medical education among healthcare professionals [33]. This trend became even more pronounced during the challenges posed by the COVID-19 pandemic [19–21, 34]. However, the question of whether webinars should be conducted in-person or virtually has elicited mixed responses in the post-webinar survey. This varied response encourages us to reassess the reasons against webinars among the healthcare professionals in Singapore and explore alternative approaches for delivering DOHaD education as we navigate beyond the pandemic. It is crucial to maintain a delicate balance between ensuring accessibility for a diverse group of healthcare professionals and achieving effective knowledge dissemination.

Strengths of study

To the best of our knowledge, this is the first study assessing a curated webinar series on the topic of DOHaD, which was delivered to a wide spectrum of healthcare professionals from private and primary care facilities as well as tertiary public hospitals. The findings from this study hold great significance, providing valuable insights that can guide the enhancement of the DOHaD educational program's future webinar series. Ultimately, these efforts aim to promote the widespread clinical application of DOHaD principles across the community and healthcare institutions, with the overarching goal of enhancing MCH on a population-wide scale in the long term.

Limitations of study

The pragmatic design of this study, while valuable for its real-world applicability, brings forth certain limitations. The flexibility in implementing interventions reflects real-world conditions but may introduce variability in the delivery of educational webinars based on presenter style and preferences. This variability could potentially influence the consistency of participant experiences and knowledge acquisition. Consequently, the generalizability of our study findings may be constrained by the contextual nuances of how the webinars were delivered within the framework of our HELMS initiative, specifically tailored for healthcare professionals in Singapore.

Additionally, the lack of a pre-webinar survey, stemming from our pragmatic study design, constitutes another limitation. This pre-webinar survey could have offered valuable insights into participants' initial perspectives before engaging with the HELMS webinar series, allowing

for a more comprehensive assessment of the webinars' impact on their knowledge and attitudes [35].

Furthermore, the study's pragmatic design introduces potential response bias. Our median survey response rate was 25.0 %, though comparable to another education webinar (26.7 %) [28]. The optional nature of the post-webinar surveys may have biased results towards more engaged and satisfied participants, posing a potential threat to the study's internal validity. Relying on biased positive results from underrepresented populations may impede the improvement of the webinar series, and the number of unengaged or disinterested participants could potentially grow, reducing the reach of target participants over time.

Lastly, the absence of participant demographic information in the anonymous post-webinar survey limits our statistical analysis to descriptive statistics. This impedes the exploration of associations between participant demographics and survey responses, hindering the unveiling of potential meaningful patterns. Understanding these patterns are important for tailored strategies targeting specific participant subgroups, enhancing knowledge acquisition, and bridging the knowledge–practice gap in various professional and organizational contexts.

Future works and application

To advance future studies in this field, we can take practical steps to enhance the impact and applicability of similar educational initiatives.

Firstly, it is recommended to implement pre-post assessments for participants, measuring knowledge levels before and after the webinar series. This direct measure of knowledge acquisition allows for an in-depth evaluation of the immediate impact and knowledge retention [36], guiding continuous improvements in content and delivery methods to enhance the overall education program.

Secondly, to ensure robust and applicable study outcomes, personalized invitations and reminders efforts should be made to improve survey response rates and obtain a more representative sample. Proactively integrating demographic details into survey designs will facilitate a comprehensive analysis of participant profiles, optimizing knowledge transfer in various professional and organizational contexts.

Moreover, future research should conduct a comparative analysis of various educational formats, including online courses, webinars, and interactive workshops. This analysis aims to identify the most effective method for sustained improvements in DOHaD-related KAP among healthcare professionals [37]. Additionally, exploring content customization for specific healthcare disciplines, such as nursing, obstetrics, or pediatrics, is essential to ensure relevance and engagement.

Simultaneously, an investigation into the barriers and facilitators that impact healthcare professionals' the successful integration of DOHaD principles into their clinical practice is essential [38]. Identifying the factors that hinder or support the implementation of DOHaD knowledge can inform strategies to optimize the educational program and enhance its impact [38]. For instance, a focus group discussion among healthcare professionals may reveal a deficiency in relation to the practical application of DOHaD principles in routine patient care settings, hindering their successful integration. Addressing this barrier could involve developing targeted educational modules featuring practical scenarios and case studies, illuminating the direct application of DOHaD principles in clinical practice. These adjustments have the potential to significantly enhance healthcare professionals' confidence and skills, facilitating the effective implementation of DOHaD knowledge in their day-to-day patient interactions. These future research directions aim to refine and tailor DOHaD education for various healthcare specialties, addressing the challenges and opportunities that healthcare professionals encounter in adopting DOHaD principles.

Conclusions

In conclusion, our study provides valuable early insights into the outreach and immediate effectiveness of the HELMS webinar series, participated predominantly by nurses. The consistent positive feedback and relative high attendance rates highlight the growing interest and willingness among healthcare professionals to bridge the knowledge–practice gap in MCH.

Our positive results of a webinar-based educational initiative specifically tailored for DOHaD education not only holds promise for enhancing MCH practices but also serves as a blueprint for future DOHaD education initiatives and similar interventions, including broader public health initiatives targeting a life-course approach, such as promoting healthy longevity [39].

The ultimate goal of achieving improved MCH on a population-wide scale hinges on the widespread clinical application of DOHaD principles among healthcare professionals. Therefore, continuous initiatives to seamlessly integrate DOHaD education into routine healthcare practices

are essential for a lasting and widespread impact, heralding a transformative shift in healthcare practices towards improved maternal and child outcomes.

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Research ethics: Ethical review and approval were not required for this study as unidentified data was used and anonymous post-webinar surveys were administered.

Informed consent: Written informed consent was not required as unidentified data was used and anonymous post-webinar surveys were administered.

Author contributions: Chee Wai Ku and Roderica R. G. Ng contributed equally to this work. Fabian K. P. Yap and See Ling Loy supervised this work equally. Conceptualization, Chee Wai Ku, Roderica R. G. Ng, Mei Chien Chua, Jerry K. Y. Chan, Fabian K. P. Yap. and See Ling Loy; methodology, Chee Wai Ku, Roderica R. G. Ng, Mei Chien Chua, Jerry K. Y. Chan, Fabian K. P. Yap and See Ling Loy; formal analysis, Chee Wai Ku, Roderica R. G. Ng and Ruther Teo Zheng; investigation, Chee Wai Ku and Roderica R. G. Ng; resources, Weini Ma, Mei Chien Chua, Jerry K. Y. Chan, and Fabian K. P. Yap; data curation, Chee Wai Ku, Roderica R. G. Ng, Ruther Teo Zheng and Weini Ma; writing – original draft preparation, Chee Wai Ku, Roderica R. G. Ng, Ting Yu Chang, Celeste H. F. Lim, and Ruther Teo Zheng; writing – review and editing, all authors; visualization, Ruther Teo Zheng; supervision, Mei Chien Chua, Jerry K. Y. Chan, Fabian K. P. Yap and See Ling Loy; funding acquisition, Mei Chien Chua, Jerry K. Y. Chan, and Fabian K. P. Yap. All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

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Data availability: The raw data can be obtained on request from the corresponding author.

References

1. Fleming TP, Watkins AJ, Velazquez MA, Mathers JC, Prentice AM, Stephenson J, et al. Origins of lifetime health around the time of conception: causes and consequences. Lancet 2018;391: 1842–52.
2. Musillo C, Berry A, Cirulli F. Prenatal psychological or metabolic stress increases the risk for psychiatric disorders: the "funnel effect" model. Neurosci Biobehav Rev 2022;136:104624.
3. Agarwal P, Morriseau TS, Kereliuk SM, Doucette CA, Wicklow BA, Dolinsky VW. Maternal obesity, diabetes during pregnancy and epigenetic mechanisms that influence the developmental origins of cardiometabolic disease in the offspring. Crit Rev Clin Lab Sci 2018;55: 71–101.
4. Baird J, Jacob C, Barker M, Fall CH, Hanson M, Harvey NC, et al. Developmental origins of health and disease: a lifecourse approach to the prevention of non-communicable diseases. Healthcare 2017;5:14.
5. Calkins K, Devaskar SU. Fetal origins of adult disease. Curr Probl Pediatr Adolesc Health Care 2011;41:158–76.
6. Pullar J, Wickramasinghe K, Demaio AR, Roberts N, Perez-Blanco KM, Noonan K, et al. The impact of maternal nutrition on offspring's risk of non-communicable diseases in adulthood: a systematic review. J Glob Health 2019;9:020405.
7. Ku CW, Leow SH, Ong LS, Erwin C, Ong I, Ng XW, et al. Developing a lifestyle intervention program for overweight or obese preconception, pregnant and postpartum women using qualitative methods. Sci Rep 2022;12:2511.
8. McKerracher L, Moffat T, Barker M, McConnell M, Atkinson SA, Murray-Davis B, et al. Knowledge about the Developmental Origins of Health and Disease is independently associated with variation in diet quality during pregnancy. Matern Child Nutr 2020;16: e12891.
9. Oyamada M, Lim A, Dixon R, Wall C, Bay J. Development of understanding of DOHaD concepts in students during undergraduate health professional programs in Japan and New Zealand. J Dev Orig Health Dis 2018;9:253–9.
10. Clark H, Coll-Seck AM, Banerjee A, Peterson S, Dalglish SL, Ameratunga S, et al. A future for the world's children? A WHO-UNICEF-Lancet Commission. Lancet 2020;395:605–58.
11. HM Government. Healthy lives, healthy people: our strategy for public health in England [online]. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/216096/dh_127424.pdf [Accessed 22 Sep 2023].
12. World Health Organization Regional Office for Europe. Good maternal nutrition: the best start in life [online]. https://iris.who.int/handle/10665/329459 [Accessed 22 Sep 2023].
13. Stephenson J, Vogel C, Hall J, Hutchinson J, Mann S, Duncan H, et al. Preconception health in England: a proposal for annual reporting with core metrics. Lancet 2019;393:2262–71.
14. Molinaro ML, Evans M, Regnault TRH, de Vrijer B. Translating developmental origins of health and disease in practice: health care providers' perspectives. J Dev Orig Health Dis 2021;12:404–10.

15. McMullan RL, Fuller NR, Caterson ID, Celermajer DS, Gordon A, Hespe C, et al. Developmental origins of health and disease: who knows? Who cares? J Paediatr Child Health 2017;53:613–14.
16. Yap F, Loy SL, Ku CW, Chua MC, Godfrey KM, Chan JKY. A Golden Thread approach to transforming Maternal and Child Health in Singapore. BMC Pregnancy Childbirth 2022;22:561.
17. Ku CW, Kwek LK, Loo RSX, Xing HK, Tan RCA, Leow SH, et al. Developmental origins of health and disease: knowledge, attitude and practice of obstetrics & gynecology residents, pediatric residents, and medical students. Women Health 2023;63:175–85.
18. Chiswell M, Smissen A, Ugalde A, Lawson D, Whiffen R, Brockington S, et al. Using webinars for the education of health professionals and people affected by cancer: processes and evaluation. J Cancer Educ 2018;33:583–91.
19. Walther LE, Blödow A, Volkenstein S, Dazert S, Löhler J. Webinar-based continuing medical education in otorhinolaryngology during the COVID-19 pandemic in Germany: a longitudinal study. BMJ Open 2021; 11:e049687.
20. McMahon CJ, Tretter JT, Faulkner T, Krishna Kumar R, Redington AN, Windram JD. Are e-learning Webinars the future of medical education? An exploratory study of a disruptive innovation in the COVID-19 era. Cardiol Young 2021;31:734–43.
21. Yo EC, Witjaksono AN, Fitriani DY, Werdhani RA, Parikesit D. Assessing webinar outcomes for health professionals: a perspective from Indonesia during coronavirus disease 2019 pandemic. Korean J Med Educ 2021;33:87–96.
22. Wutoh R, Boren SA, Balas EA. eLearning: a review of Internet-based continuing medical education. J Contin Educ Health Prof 2004;24: 20–30.
23. Jang A, Kim MR, Lee SMK, Ha IH, Shin JY, McClain R, et al. Evaluating the effectiveness of online Continuing medical education during the COVID-19 pandemic. Med Teach 2023;45:852–8.
24. Ministry of Health. Primary healthcare services [online]. https://www.moh.gov.sg/home/our-healthcare-system/healthcare-services-and-facilities/primary-healthcare-services [Accessed 22 Sep 2023].
25. Ministry of Health. Speech by Dr Lam Pin Min, Senior Minister of State, Ministry of Transport and Ministry of Health, at the Ministry of Health Committee of Supply Debate 2020, on Thursday 5 March 2020 [online]. https://www.moh.gov.sg/news-highlights/details/speech-by-dr-lam-pin-min-senior-minister-of-state-ministry-of-transport-and-ministry-of-health-at-the-ministry-of-health-committee-of-supply-debate-2020-on-thursday-5-march-2020 [Accessed 22 Sep 2023].
26. KK Women's and Children's Hospital. Obstetrics [online]. https://www.kkh.com.sg/about-kkh/corporate-profile/clinical-outcomes/Pages/obstetrics.aspx [Accessed 22 Sep 2023].
27. Elsayes KM, Marks RM, Kamel S, Towbin AJ, Kielar AZ, Patel P, et al. Online liver imaging course; pivoting to transform radiology education during the SARS-CoV-2 pandemic. Acad Radiol 2021;28:119–27.
28. Yost J, Mackintosh J, Read K, Dobbins M. Promoting awareness of key resources for evidence-informed decision-making in public health: an evaluation of a webinar series about knowledge translation methods and tools. Front Public Health 2016;4:72.
29. Ministry of Health. Health manpower [online]. https://www.moh.gov.sg/resources-statistics/singapore-health-facts/health-manpower [Accessed 22 Sep 2023].
30. Ministry of Health. Caring for our people: 50 years of healthcare in Singapore [online]. https://www.mohh.com.sg/Documents/book/caring-for-our-people-50-years-of-healthcare-in-singapore.pdf [Accessed 22 Sep 2023].
31. Foo C, Chia HX, Teo KW, Farwin A, Hashim J, Choon-Huat Koh G, et al. Singapore's multi-year strategy to transform primary healthcare. Lancet Reg Health West Pac 2023;37:100861.
32. Tan CC, Lam CSP, Matchar DB, Zee YK, Wong JEL. Singapore's health-care system: key features, challenges, and shifts. Lancet 2021;398: 1091–104.
33. Gegenfurtner A, Ebner C. Webinars in higher education and professional training: a meta-analysis and systematic review of randomized controlled trials. Educ Res Rev 2019;28:100293.
34. Patel NM, Khajuria A, Khajuria A. Utility of a webinar to educate trainees on UK core surgical training (CST) selection – a cross sectional study and future implications amidst the COVID-19 pandemic. Ann Med Surg 2020;59:35–40.
35. Landry S, Collie-Akers V, Foster K, Pecha D, Abresch C. Assessing the development of collective impact initiatives addressing maternal and child health. Matern Child Health J 2020;24:405–11.
36. Latimier A, Riegert A, Peyre H, Ly ST, Casati R, Ramus F. Does pre-testing promote better retention than post-testing? NPJ Sci Learn 2019;4:15.
37. Ebner C, Gegenfurtner A. Learning and satisfaction in webinar, online, and face-to-face instruction: a meta-analysis. Front Educ 2019;4:92.
38. Reis T, Faria I, Serra H, Xavier M. Barriers and facilitators to implementing a continuing medical education intervention in a primary health care setting. BMC Health Serv Res 2022;22:638.
39. Fried LP, Wong JE, Dzau V. A global roadmap to seize the opportunities of healthy longevity. Nat Aging 2022;2:1080–3.