ORIGINAL ARTICLE

Knowledge and Attitude of Pregnant Women Towards Cord Blood Banking in Hospital Kuala Lumpur

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ABSTRACT

Introduction: Umbilical cord blood (UCB) is a valuable, non-invasive, and easily accessible hematopoietic stem cell source used as an alternative to bone marrow transplantation for over three decades. Studies worldwide have shown that pregnant women have poor knowledge about cord blood banking (CBB), which leads to most of the UCB being discarded at birth. This study aimed to assess pregnant women's knowledge and attitude towards CBB in Kuala Lumpur, Malaysia. **Methods:** A cross-sectional study was conducted among 322 pregnant women attending the antenatal clinic in Hospital Kuala Lumpur from November 2019 to March 2020. Data was collected using a self-administered questionnaire with 34 questions covering sociodemographic, knowledge measure and attitude determinants. A sequence of steps was performed to develop and validate the questionnaires. The data was analysed using SPSS version 26.0. **Results:** The majority of the participants were of Malay ethnicity, multigravida, in their third trimester, had at least one child, had tertiary education and were private employees. Only 11.5% of the participants had fundamental knowledge of CBB. Only 23% of participants had a positive attitude towards CBB. A statistically significant relationship was found between knowledge score and attitude ($p<0.001$). **Conclusion:** This study demonstrates a significant lack of knowledge and a negative attitude among pregnant women. They were inadequately informed about CBB and thus, reluctant to donate or store their UCB. Therefore, comprehensive strategies should be formulated to disseminate accurate information to pregnant women, especially by healthcare professionals.

Keywords: Umbilical cord blood, Cord blood banking, Pregnant women, Knowledge, Attitude

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INTRODUCTION

Cord blood is a major area of interest within the field of regenerative medicine. Umbilical cord blood (UCB) is a rich source of hematopoietic stem cells (HSC) equivalent to that found in the bone marrow, and it is useful for hematopoietic stem cell transplantation (HSCT) (1). The first successful related umbilical cord blood transplantation (UCBT) was performed on 6 October 1988 in Paris, France in a 5-year-old boy with Fanconi anaemia (2). To date, the Food and Drug Administration (FDA) has approved the use of UCB hematopoietic stem cells as standard care treatment for nearly 80 diseases involving non-malignant and malignant diseases (3). Approximately more than 40,000 UCBTs have been performed worldwide up to the present time (4), and the World Health Organization (WHO) has reported that more than 2000 UCBT are carried out annually (5). Exciting novel applications of UCB for regenerative therapy are now being explored. Many studies have been published on the novel UCB cell-based therapy, particularly involving neurologic disorders, diabetes mellitus type 1 and cardiovascular diseases (6). Recently, mesenchymal stem cells in cord blood have been evaluated for the treatment of severe COVID-19 in clinical trials (7). However, these unconventional practices of UCBT are still limited to clinical trials and further assessment to demonstrate its safety profile and clinical benefits are required (6).

Stem cells collected from the UCB provide several distinct advantages over the use of bone marrow or peripheral stem cells. Advantages include easy and non-invasive collection without risk to mother or newborn, less risk of viral contamination, rapid availability, reduced incidence, and severity of graft-versus-host disease (GVHD), expanded donor pool, and less stringent human leukocyte antigen (HLA) matching requirements which allow 1-2 HLA mismatches out of 6 (8). That could be attributed greatly to the fact that UCB stem cells are immunogenically naïve. Thus, it is proposed as an alternative option, particularly for patients of racial or ethnic minorities when an HLA matched adult

donor is unavailable or when the time to transplant is very critical (9). However, delayed engraftment and graft failure caused by a limited number of hematopoietic progenitor cells in a single cord blood unit are the main disadvantages of UCB, particularly when it is used in an adult patient. Besides, a significant risk of infection-related morbidity and mortality and increased cost also contributed (10).

Utilising UCB for HSCT with promising outcomes and growing clinical trials for exciting novel therapies have contributed to the establishment of public and private cord blood banks. Public cord blood banks collect, process, and store donated UCB units, and the government funds them. These units are made available to the public in need of HSCT around the world. Meanwhile, the private bank collects directed cord blood donations for the exclusive use of the family who banked it. Private banks apply charges for processing and storing the UCB units. The American College of Obstetricians and Gynecologists (ACOG) recommends storing cord blood in private banks only when warranted by the presence of medical conditions requiring related UCBT (11). The rationale behind this recommendation is that the likelihood of a person using an autologous UCB unit later in life is estimated to be very low and the presence of an inherited genetic disorder may hinder autologous UCBT (12). Presently, more than 800,000 UCB units are cryopreserved in public banks across 45 countries, and on average, 4100 units are released annually for transplantation (13). Whereas approximately 4 million UCB units are being stored in private banks worldwide, but the number of units released for clinical use is much lower, at only about 130 units per year (13). Greater demand for UCB units in unrelated allogeneic transplants necessitates access to a large number of UCB units in public cord blood banks. To find a good HLA matched UCB unit, public banks are required to have an optimal inventory depending on the population size and presence of ethnic minorities (14).

As a country that performs a large number of UCBTs in the Asia-Pacific region, Japan has six public cord blood banks with 11 287 cord blood units cryopreserved as of March 2017 and facilitates more than 1300 unrelated cord blood transplants annually (15). The Singapore Cord Blood Bank, the internationally accredited Singapore's public cord blood bank, was established in 2005 for unrelated UCBT. The non-profit, Southeast Asia's biggest public cord blood bank has over 11,000 units in its inventory. It has successfully facilitated over 282 cord blood transplants in Singapore and 15 other countries worldwide as of 1 February 2021 (16).

In Malaysia, the first experience of umbilical cord blood transplantations began much earlier than the existence of cord blood banks in the country. Chan and Lin reported the first successful, related UCBT in Malaysia in a two-year-old boy with beta-thalassemia major (17). From 1997 until 2016, 107 cord blood or cord blood and marrow co-transplantations were performed in which 78 transplants involved unrelated cord blood units (18). In Malaysia, the first Public Cord Blood Bank housed in the National Blood Centre (NBC) was established in 2002 following an anticipated demand for HSCT. As the country's largest public cord blood bank, it has cryopreserved nearly 7500 transplantable UCB units to date. Several private companies are providing UCB banking services in Malaysia.

The evolving use of HSCT for various disease in the country has led to increased requests for allogeneic stem cells made to the National Bone Marrow Registry and Cord Blood Bank in NBC via the National Stem Cell Coordinating Centre (NSCCC). The possibility of finding an unrelated HLA matched UCB will be greater if a public CBB has an inventory of 1 or 2 UCB units per 1000 population (19). Unfortunately, the Cord Blood Bank in NBC has cryopreserved only around 25% of the suggested optimal inventory due to low clinical conversion rate secondary to insufficient quantity or poor quality of stem cells obtained from the UCB. Exploring technical and clinical requirements for collecting high-quality UCB units poses a significant challenge to the CBB field, which can be mitigated in part by increasing the number of cord blood collections.

Studies were conducted in various countries to explore pregnant women's knowledge and attitudes toward UCB banking in Asia, Australia, Europe, America, and Africa (20-31). In general, participants have reported a lack of knowledge about cord blood banking. Only a few studies have been identified to report a high level of awareness among the study participants (30,31). Positive attitudes were found among the participants, with altruism being the most common reason for their desire to donate cord blood (24,26,27,32). Insufficient information and a low education level were frequently recognised as factors associated with poor knowledge levels. Pregnant women were often reluctant to consider donating or storing their cord blood when they were inadequately informed about this issue due to lack of motivation (20,21). Many studies have identified healthcare professionals (HCPs), especially antenatal care providers, as the most preferred and trustworthy source of information on CBB for pregnant women (25,28,30). Receiving information from HCPs about CBB highly impacted the decision of parents to donate or store their child's UCB (33).

The community's acceptance towards UCB donation is poorly understood and has become a primary concern. It is crucial to assess the knowledge level about cord blood banking in our population because knowledge plays an important role in influencing a person's understanding and attitude towards CBB whether to throw away UCB as medical waste or store it in the bank. Therefore, this study aimed to assess and analyse the knowledge

and attitude of CBB among pregnant women in Kuala Lumpur, Malaysia. The Women and Children's Hospital, Hospital Kuala Lumpur (renamed as Tunku Azizah Hospital) was selected as the study location since it is the largest contributor of cord blood units to Malaysia's public collection centre with nearly 11,000 births per year. It is believed that information obtained from this study would contribute to the expansion of the national cord blood collection program in the future.

MATERIALS AND METHODS

A cross-sectional design approach was used to conduct this research. Ethical approval from the Human Research Ethics Committee Universiti Sains Malaysia (USM/JEPeM/18110728) and the Medical Research and Ethics Committee Ministry of Health (NMRR-18-3100-44622) were obtained prior to conducting this study. The study was conducted from November 2019 to March 2020 at antenatal care clinic in the Obstetrics and Gynaecology Department of Women and Children Hospital, Hospital Kuala Lumpur (renamed as Tunku Azizah Hospital). Pregnant women at any gestational period, Malaysian citizens, aged ≥ 18 years old and able to read, write and understand the Malay language were included in the study. Participants who do not provide informed study consent, illiterate, who had participated in the pilot study and healthcare staff were excluded. The sample size was calculated using a single proportion formula with a confidence interval of 95%, precision estimate of 5%, p (population prevalence) of 26.5% for proportion with adequate knowledge which gave the sample size of 295 (22). Considering 10% subject dropout, a sample size of 325 pregnant women was required.

Data were collected using a self-administered structured questionnaire. A sequence of steps was performed to design and validate the research questionnaire. The questionnaire was developed in the Malay language, Malaysia's national language, based on an extensive literature review and with the help of brochures and educational tools about CBB produced by the Ministry of Health, Malaysia. Some items in the questionnaire were adapted and modified from previous studies' validated questionnaires (22-25). Permissions to adapt the questionnaires were obtained from the authors. Other newly developed items were incorporated into the questionnaire to address the objectives of our study adequately. The questionnaire had a total of 34 questions and consisted of three major sections: (i) sociodemographic, (ii) knowledge measure, and (iii) attitude determinant. The first section referred to the sample demographics, such as age, race, gravidity, number of children, gestational age, education level, occupation, household income, and source of knowledge regarding CBB. The second section to assess the knowledge of CBB comprised 18 close-ended questions using three response options: 'True, False, Unsure'. This section included questions about the definition of cord blood, cord blood collection, storage, its uses and the concept of cord blood banking. The third section consisted of six close-ended questions that determine the attitude towards CBB, from the willingness to store UCB to the bank model preference.

Five experts consist of a Transfusion Medicine Specialist, a Family Medicine Specialist, a Clinical Hematologist, an Obstetrics & Gynecology Specialist, and a Pediatrician evaluated the content validity of the newly developed questionnaire. All the knowledge and attitude items had an item-level content validity index (I-CVI) score of ≥ 0.8; thus, all items were considered appropriate. Some items were rephrased to improve the clarity of the items and the questionnaire was finalised in terms of content and construct based on the team experts' feedback and comments. Face validity was assessed by 30 pregnant women at the antenatal clinic, Hospital Kuala Lumpur. Subsequently, a pilot study was conducted among 121 pregnant women at the antenatal clinic, Hospital Kuala Lumpur. The test-retest method was also applied whereby 30 participants from the pilot study were tested twice with the same questionnaires. The psychometric properties of the items assessing the knowledge domain were evaluated using item response theory (IRT) analysis and showed good psychometric properties based on the difficulty and discriminatory values. Regarding the reliability of the questionnaire, the Cronbach's alpha of the internal consistency reliability and the intraclass correlation coefficient (ICC) value of the test-retest reliability for the knowledge items was 0.831 and 0.887 respectively, indicating good reliability. Therefore, the questionnaire was considered a reliable tool to assess cord blood banking knowledge among pregnant women. Items in the attitude domain were not evaluated for their psychometric properties as only one item from this domain was used to assess the attitude.

Participants were recruited through a systematic sampling from pregnant women attending the antenatal care clinic. Every third registered woman was recruited. Pregnant women who full fill the inclusion criteria were invited to join the study. Interested pregnant women were provided with a written summary of information about the study. Written consent for participation was obtained. The researcher or research assistant distributed the self-administered questionnaire to the participants to be answered by themselves. The questionnaire needed approximately 20 minutes to be completed. To ensure anonymity and confidentiality of the participants, the completed questionnaire and consent form were collected separately. The data were presented as group data and didn't identify the subjects individually.

This study used a scoring scheme for the knowledge section. A correct response was assigned one point, while an incorrect or unsure response was assigned zero points. The total score ranged from 0–18, with a higher score indicated better knowledge of CBB. A participant

whose answer was correct for six core items in the knowledge domain (items 11, 12, 15, 19, 21b and 22) was considered to have fundamental knowledge about CBB. For the attitude section, the response was categorised as a positive attitude if the participant answered the question 'Are you willing to store umbilical cord blood?' as 'Yes' or as a negative attitude if the answer was 'No' or 'Unsure'.

The data were coded for entry and analysed using SPSS version 26.0 for Windows (SPSS, Chicago, IL, USA). All study variables were analysed using descriptive statistics and presented as mean ± SD for continuous variables and frequency (percentages) for categorical variables. Simple logistic regression was used to evaluate the association between knowledge score and attitude. Associations between sociodemographic characteristics of pregnant women and their knowledge scores were analysed using simple and multiple linear regression analyses. Meanwhile, to determine the associations between sociodemographic factors and their attitude towards cord blood banking, simple and multiple logistic regression analyses were used. Variables with a p-value <0·25 in univariable analysis were selected for multivariable analysis. Statistical significance was defined as a p-value less than 0.05.(p <0·05).

RESULTS

Participant Characteristics

The sociodemographic characteristics of the respondents are represented in Table I. A total of 322 pregnant women completed the questionnaire given to them. The majority of them were in the 24 to 34-year age group (72.0%), of Malay ethnicity (82.3%), multigravida (70.8%), in their third trimester (64.9%), had at least one child (67.7%), had tertiary education (65.2%) and were private employees (42.9%). Only 38% of the women had information about cord blood banking, and one-third of them received information through healthcare providers.

Table I: Sociodemographic and obstetric characteristic of respondents (N=322)

Demographic characteristics	n (%)
Age (years)	30.4 ± 5.2*
Race	
Malay	265 (82.3)
Chinese	19 (5.9)
Indian	21 (6.5)
Others	17 (5.3)
Gravidity	
Primigravida	94 (29.2)
Multigravida	228 (70.8)
Number of children	
0	104 (32.3)
1	106 (32.9)
≥ 2	112 (34.8)
Gestational age	
≤12 weeks	19 (5.9)
13-27 weeks	94 (29.2)
≥28 weeks	209 (64.9)
Educational level	
No formal education	1 (0.3)
Primary school	2 (0.6)
Secondary school	109 (33.9)
Diploma/ certificate	113 (35.1)
Degree/ advanced degree	97 (30.1)
Occupation	
Government	61 (18.9)
Private	138 (42.9)
Self-employed	17 (5.3)
Unemployed	106 (32.9)
Household income (Ringgit Malaysia)	4169 ± 2520*
Aware of cord blood banking	
Yes	122 (37.9)
No	200 (62.1)
Source of information	
Brochure	18 (14.8)
Newspaper/magazine	3 (2.5)
Healthcare provider	43 (35.2)
Television/ radio	9 (7.4)
Social media	21 (17.2)
Family/friend	15 (12.3)
Internet	11 (9.0)
Others	2 (1.6)

* Mean ± SD

Knowledge and attitude of pregnant women toward CBB

Table II shows the frequency distribution of knowledge about cord blood banking. The mean knowledge score was 5.81 ± 4.50 (range 0-18) with the average correct answer rate of just 32.3%. Less than 25% of participants were able to obtain a score above one-half of the total scores. Only 11.5% of the participants had fundamental knowledge about CBB.

Regarding the participant's attitude towards cord blood banking, only 74 (23%) had a positive attitude (Table III). A statistically significant relationship was found between knowledge score and attitude, as shown in Table IV.

Factors associated with knowledge score of pregnant women toward CBB

Education level and being aware of cord blood banking significantly associated with knowledge score as indicated in Table V. Respondents with tertiary

Table II: Frequency distribution of the knowledge about CBB (N=322)

Knowledge statement	Correct respondents n (%)
Umbilical cord blood is the blood that remains in the umbilical cord and the placenta after the birth of a baby	234 (72.7)
Umbilical cord blood is rich in blood stem cell	192 (59.6)
Blood stem cells are potential to form different types of blood component such as red blood cell, white blood cell and platelet	175 (54.3)
Cord blood is usually discarded as medical waste if not collected and stored in cord blood bank	122 (37.9)
Cord blood is collected before delivery of the baby	137 (42.5)
Cord blood can be collected from natural births	98 (30.4)
Cord blood can be collected from Caesarean sections	84 (26.1)
Placenta and umbilical cord will not be returned to the donor after cord blood collection	85 (26.4)
Cord blood collection procedure is safe and painless for the mother and the baby	162 (50.3)
Cord blood can be preserved in the cord blood bank for 10 years only	18 (5.6)
Cord blood can help in the treatment of diseases as follows:	
a) Thalassemia	111 (34.5)
b) Leukemia	111 (34.5)
c) Diabetes	45 (14.0)
d) Hemophilia	15 (4.7)
e) Bone fracture	44 (13.7)
Cord blood is one of the options for patients who need a bone marrow transplant	93 (28.9)
Pregnant women who did not register for antenatal checkup (no pink book) are eligible to donate cord blood	81 (25.2)
Public cord blood bank is for the use of donor's family members only	65 (20.2)

education had 1.99 knowledge scores higher than those with secondary or lower education level (adjusted β =1.991, 95% CI 0.970, 2.851, p-value<0.001). Similarly, pregnant women who were aware of CBB had 3.68 knowledge score higher than those who had never heard about it previously (adjusted β = 3.679, 95% CI 2.717, 4.641, p-value<0.001). About 22% of the variation in knowledge score were explained by these two variables.

Factors associated with the attitude of pregnant women toward CBB

Regarding the factors influencing participants' attitudes, occupation and existing awareness about cord blood banking were significant, as shown in Table VI.

Table III: Attitude analysis towards CBB

Attitude Analysis	n (%)
Willingness to store umbilical cord blood (n=322)	
Yes	74 (23.0)
No	72 (22.4)
Unsure	176 (54.6)
Reasons for negative attitude towards cord blood banking (n=248)	
Not interested	40 (16.1)
Not allowed by the family	34 (13.7)
Inadequate Information	150 (60.5)
Not allowed by religion	7 (2.8)
Others	17 (6.9)
Cord blood bank preference (n=286)	
Public cord blood bank	262 (91.6)
Private cord blood bank	24 (8.4)
Reason for preferring public cord blood bank (1st best option) (n=262)	
For the benefit of patients in need	221 (84.3)
The cost of private cord blood bank is high	29 (11.1)
Unlikely child would ever need his/her cord blood transplantation	11 (4.2)
Other reasons	1 (0.4)
Reason for preferring private cord blood bank (1st best option) (n=24)	
Health insurance in the future	17 (70.8)
Own cord blood is thought to be safer than that of others	7 (29.2)
Cost is acceptable	0 (0.0)
Other reasons	0 (0.0)
Willingness to donate umbilical cord blood for research (n=322)	
Yes	144 (44.7)
No	178 (55.3)

Table IV: Association between knowledge score and attitude towards CBB

	Mean (SD)		β	OR (95% CI)	P-value
	Positive Attitude	Negative Attitude			
Knowledge score	8.12 ± 4.646	5.13 ± 4.227	0.150	1.162 (1.094,1.235)	<0.001

β =regression coefficient
OR = odds ratio, CI = confidence interval.

Government employees had 2.3 times more likely to have a positive attitude toward CBB compared to unemployed women (OR 2.329, 95% CI 1.089, 4.981, p-value =0.029). Similarly, participants who were aware of cord blood banking were 2.4 times more likely to store UCB compared to those who had never heard about CBB (OR 2.441, 95% CI 1.414, 4.215, p-value =0.001).

DISCUSSION

This is the first study in Malaysia to explore pregnant women's knowledge and attitude towards cord blood banking. The study identified the level of knowledge about cord blood banking among pregnant women was generally low. Although over half of the study participant (60%) knew that cord blood is a rich source of HSC, only 18% knew the primary use of UCB and more than 90% didn't know about the cord blood collection process and storage. About 80% of those surveyed also didn't know the concept of public CBB. Previous studies

Table V: Sociodemographic factors influencing knowledge score of CBB

Demographic characteristics	Simple linear regression			Multiple linear regression		
	Crude β (95% CI)	t-statistics	P-value	Adjusted β (95% CI)	t-statistics	P-value
Age (years)	0.071(0.025,0.166)	1.459	0.145			
Race						
Malay	1.000					
Chinese	2.828(0.747,4.909)	2.675	0.008			
Indian	-0.074(-2.088,1.941)	-0.072	0.943			
Others	0.119(-2.103,2.341)	0.106	0.916			
Gravidity						
Primigravida	1.000					
Multigravida	-0.594(-1.679,0.491)	-1.077	0.282			
Number of children						
0	1.000					
1	-1.097(-2.326,0.133)	-1.758	0.080			
≥2	0.143(-1.068,1.353)	0.233	0.816			
Gestational age						
<12 weeks	1.000					
13-27 weeks	-0.212(-2.565,2.142)	-0.178	0.859			
>28 weeks	-0.354(-2.444,1.736)	-0.334	0.739			
Educational level						
Secondary education	1.000			1.000		
Tertiary education	2.576(1.577,3.574)	5.077	<0.001	1.991 (0.970,2.851)	3.997	<0.001
Occupation						
Unemployed	1.000					
Government	2.337(0.871,3.803)	3.147	0.002			
Private	0.748(-0.354,1.849)	1.337	0.182			
Self employed	-0.115(-2.414,2.183)	-0.099	0.921			
Household income	0.000(0.000,0.000)	2.994	0.003			
Aware of cord blood banking						
No	1.000			1.000		
Yes	3.876(2.951,4.801)	8.243	<0.001	3.679 (2.717,4.641)	7.524	<0.001
Source of information						
Brochure	1.000					
Newspaper/magazine	-1.389(-6.520,3.742)	-0.567	0.578			
Healthcare provider	0.433(-1.842,2.708)	0.381	0.705			
Television/ radio	1.389(-1.753,4.531)	0.910	0.371			
Social media	-0.246(-2.682,2.190)	-0.295	0.839			
Family/friend	-0.722(-3.028,1.584	-0.639	0.528			
Internet	-0.146(-3.236,2.943)	-0.097	0.923			
Others	5.444(-0.835,11.724)	1.822	0.085			

β=regression coefficient
Stepwise and forward multiple linear regression method applied for variable selection in multivariable model.
Model assumptions are fulfilled. There were no interactions amongst independent variables.
No multicollinearity detected.
Coefficient of determination (R^2) = 0.217

conducted in various countries have reported similar findings in which a lack of knowledge about UCB banking was observed among most participants (20-29). In a study conducted by Djuwantono et al., about 61% of Indonesian pregnant women had insufficient knowledge despite higher educational background among the respondents (28). Similar low knowledge level was also seen among Indian and Chinese pregnant women in other studies conducted in India and Hong Kong, respectively (22,29). However, few studies have

Table VI: Sociodemographic factors influencing attitude (positive vs negative) towards CBB

Demographic characteristics	Simple logistic regression		Multiple logistic regression	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Age (years)	1.021(0.971,1.073)	0.418		
Race				
Malay	1.000			
Chinese	0.892(0.285,2.787)	0.844		
Indian	1.045(0.368,2.969)	0.934		
Others	1.029(0.324,3.271)	0.961		
Gravidity				
Primigravida	1.000			
Multigravida	0.889(0.506,1.563)	0.684		
Number of children				
0	1.000			
1	0.922(0.477,1.783)	0.810		
≥2	1.230(0.657,2.304)	0.517		
Gestational age				
<12 weeks	1.000			
13-27 weeks	1.014(0.303,3.394)	0.983		
>28 weeks	1.179(0.374,3.716)	0.778		
Educational level				
Secondary education	1.000			
Tertiary education	1.346(0.768,2.361)	0.299		
Occupation				
Unemployed	1.000		1.000	
Government	2.953(1.414,6.167)	0.004	2.329(1.089,4.981)	0.029
Private	1.645(0.859,3.151)	0.133	1.562(0.807,3.022)	0.186
Self employed	0.698(0.146,3.335)	0.652	0.691(0.142,3.358)	0.647
Household income	1.000(1.000,1.000)	0.874		
Aware of cord blood banking				
No	1.000		1.000	
Yes	2.756(1.620,4.689)	<0.001	2.441(1.414,4.215)	0.001
Source of information				
Brochure	1.000			
Newspaper/magazine	0.000(0.000,0.000)	0.999		
Healthcare provider	3.341(0.946,11.800)	0.061		
Television/ radio	2.800(0.501,15.659)	0.241		
Social media	1.094(0.245,0.4891)	0.907		
Family/friend	1.273(0.258,6.273)	0.767		
Internet	1.313(0.233,7.409)	0.758		
Others	3.500(0.177,69.339)	0.411		

OR = odds ratio, CI = confidence interval.
Constant= -0.236
Forward LR and Backward LR methods were applied.
No multicollinearity and no interaction found.
Hosmer-Lemeshow test, p-value=0.817. Classification table 77.0% correctly classified. Area under Receiver Operating Characteristics (ROC) curve was 66.6%

been identified to report a high level of awareness among the study participants. The authors discovered the dissemination of information via the media and printed materials in addition to the information provided by healthcare professionals contributed to the higher knowledge levels.

Participants with higher educational level and women with existing understanding of CBB were found to have better knowledge. Strong knowledge reliance on the educational level has also been seen in similar

studies conducted by Pandey et al. in India (22) and Djuwantono et al. in Indonesia (28). A possible explanation for this might be that women with higher education backgrounds likely read more about cord blood banking and hear or discuss CBB with healthcare professionals. Several studies have demonstrated a significant association between knowledge score and other sociodemographic factors in addition to education level (21,25,27,28,34). However, age, race, gravida, parity, pregnancy duration, occupation and household income showed no correlation with knowledge level in this study.

Unfortunately, only 23% of participants had a positive attitude about UCB storage, while 22.4% refused and a large percentage (54.6%) undecided for UCB storage. A study conducted to assess potential donors' attitudes from one of India's largest UCB repositories reported that only 15% of their participants were supportive. A significant percentage (55%) was uncertain whether to bank UCB (22). In the current study, a positive association between knowledge score and attitude was demonstrated. As expected, participants with existing knowledge or awareness of UCB banking had a more positive attitude towards UCB storage. These cohorts might have a good insight and a better understanding of the benefit and clinical significance of UCB.

Interestingly, government employees were more likely to store their UCB than those employed in private sectors, self-employed or unemployed. This finding is in agreement with another study finding done in China, which showed a more positive attitude among mothers who were employed at government corporations (35). This may be attributed to the government employees' trust in government's policy and practice of public cord blood banking. Another possible explanation could be the higher educational level and prior awareness of CBB among the majority of pregnant women employed in government sectors (91% and 68% respectively), as was found in further analysis of this subgroup in the current study. This finding emphasises the importance of raising awareness among pregnant women so that they are more inclined to support CBB. There was no significant association observed between other sociodemographic factors (age, race, education level, household income and obstetric history) and attitude.

In accordance with previous reports, a substantial number of participants showed a poor attitude towards CBB, mainly due to inadequate information (60.5%) (22,28,36). The remaining 29.8% of women gave reasons for not being interested and not allowed by family. On the other hand, only a minority of respondents believed that religion is a barrier to CBB (2.8%). This is consistent with research undertaken by Jordens et al., which identified wide acceptance of umbilical CBB among six of the world's major religions (Islam, Buddhism, Hinduism, Catholicism, Anglicanism, Judaism) (37). Hence, the misconception that UCB donation is not permissible by religion is not a barrier to cultivating a positive attitude towards CBB in our population. Interestingly, more than 90% of all participants favoured donating to a public cord blood bank, if given the option, with altruism being the most common reason provided (84.3%). This attitude is an essential element in expanding the country's cord blood donor registry (23).

Meanwhile, 8.4% of pregnant women would prefer a private cord blood bank due to biological insurance, and their own cord blood is thought to be safer than that of others, which shows they are inadequately informed by misleading information. The ACOG recommends storing cord blood in private banks only when warranted by the presence of medical conditions requiring related UCBT (11). Similar observations about cord blood bank preference have also been seen in other countries (24,26,32,38). This survey revealed that less than half of respondents (44.7 %) were willing to donate to research, perhaps because information about cord blood research is not widely available to the public.

The most common information source for women who were aware of CBB was the media (42.5%). Over one-third of them (35.2%) learnt about CBB from healthcare professionals and 12.3% of women had been informed by family or friends. The findings of the current study are consistent with those of Karagiorgou et al. who reported the primary source of information for Greeks was the media (45.5%), with an additional source being healthcare professionals (36.6%) (31). Similarly, in a survey conducted in 5 European countries, only 21% of respondents had been informed by health care professionals, and the majority received information from the media (26). This may be partly due to time constraints (36) and insufficient knowledge of the medical staff themselves, as seen in some studies, not enabling them to hold assured discussions about CB banking (39). In comparison, the primary source of information was acquired from healthcare professionals in other studies in Lebanon and the Midwestern United States (21,36).

This study has found that insufficient information is the foremost hurdle restricting pregnant women from storing umbilical cord blood. Similarly, in our neighbouring country Singapore, it has been estimated that only less than 10% of pregnant women donate their baby's cord blood to the public cord blood bank due to a lack of knowledge (40). Providing pregnant women with basic information positively influences women's decisions on CBB (30,41). It is essential to provide expectant mothers with the necessary information. It is even more crucial to provide accurate and quality information to help them to make the right decision. The survey shows most pregnant women who had heard about CBB were informed via the media where there is a widespread advertisement by commercial banks for financial gain.

Therefore, obtaining information from media alone can provide incomplete and inaccurate information which creates unrealistic public expectations that can adversely influence women's decision to store cord blood (42). Strict regulation of the information provided in the media regarding CBB is warranted.

Many studies have identified healthcare professionals (HCPs) as the most preferred and trustworthy source of information on CBB for pregnant women (25,28,30,43). Antenatal care providers should play a central role in delivering appropriate, precise, and consistent information to their expectant mothers that are evidence-based, unbiased and regulated to help them make an informed decision. A reasonable approach could be information provision or education programs during routine antenatal care (43). In an integrated review, Peberdy et al. found that not many studies have investigated HCPs' understanding, knowledge, practice, attitude, and information sources pertaining to CBB (44). In a recent survey assessing HCPs' knowledge, awareness, and perception of stem cells in Malaysia, Azizah et al. identified a lack of knowledge of cord blood banking among the study participants (45). Therefore, it is essential for HCPs to be educated and trained in all aspects of CBB to enable them to discuss this with pregnant women effectively and confidently (39,46). Exploring strategies to educate HCPs, especially antenatal care providers regarding CBB is an area of potential further research that could assist the Ministry of Health to collaborate with NBC in defining effective ways to educate and train them.

This study's key strength is the use of a validated questionnaire that has good reliability and is well suited for the target population. The current research examined the participants in a single tertiary hospital in Kuala Lumpur, which is the capital of Malaysia. This is the limitation of the study as the sample reflects only the urban population, not the general population. Notwithstanding this limitation, the findings are valuable in designing and implementing cord blood banking policies and procedures for national or regional educational programs. In addition, the research findings will provide the necessary information for future investigations.

CONCLUSION

In conclusion, significant knowledge gaps in cord blood banking were identified among pregnant women, which adversely influenced parents' attitude towards cord blood banking. The majority of participants were found to be less supportive of cord blood banking. They were inadequately informed about this issue and therefore reluctant to consider donating or storing their cord blood. Comprehensive strategies should be formulated to disseminate accurate information to pregnant women. The authors strongly recommend that healthcare providers play a vital role in providing clear, evidence-based, and regulated information to expectant mothers regarding CBB to help them make the right decision. Healthcare providers need to be well equipped with adequate knowledge about scientific aspects of cord blood use, collection, cord blood banking and the latest developments in the cord blood field in order to provide correct information.

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