IMAGE: A MAP OF THE STARS OF THE ORION CONSTELLATION

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Food Taboos, Factors of Chronic Malnutrition in Bopa, South West Benin

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ABSTRACT

The quality of the diet from the first hours of life is decisive. Any inappropriate diet for pregnant women or infants has an irreversible impact on a child's bio-morphological and cognitive levels, leading to chronic malnutrition. This study assesses the factors that explain adherence to dietary taboos or restrictions and the factors statistically significantly related to the choice of nutritional restrictions in households housing stunted children under five years of age in southwest Benin.

Data were collected in December 2020 on a sample of 558 families in 40 villages in the commune of Bopa in southwest Benin. Socioeconomic data from families, and anthropometric data from children (498) are analyzed within univariate, bivariate and binary logit regression methods.

Results show that 36.3% of children are stunted, and 76.2% of households with stunted children have food taboos. In addition, 69.6% of households have at least one taboo on consuming beef, goat, poultry, pork, eggs, and fish, reducing in-take of the required micronutrients child growth. The gender of the head of the household, their occupation, religion, level of education, age category, area of residence, level of education of the wife of the head of the household, and average monthly household income have statistically significant effects on adherence to food taboos and restrictions in the household diet. To effectively combat stunting, advocacy targeting religious leaders and the local elite is needed.

Keywords: food taboos, livelihoods, stunting, nutrition.

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I. INTRODUCTION

Eradicating hunger and malnutrition and ensuring access to safe, nutritious, and adequate food by 2030 is the second Sustainable Development Goal (SDG) as agreed by the international community since 2015. Seven years later, limited access to food is still driving a higher rate of malnutrition. Globally, pregnant women and children under five are most at risk of malnutrition. United Nations Children's Fund, World Health Organization, and World Bank estimated in 2015 that 23.8% of children under five (159 million) were affected by chronic malnutrition worldwide (UNICEF, WHO, World Bank, 2015; Amadou et al., 2020). But all continents are not equally affected.

Perez-Escamilla et al. (2018) and Traoré et al. (2020) works found that nearly 32% of children under five living in developing countries have one of the highest rates of stunting or chronic malnutrition. The stunting rate is 46% in South Asia, 38% in Sub-Saharan Africa, and 25% in the Middle East and North Africa (Traoré et al., 2020), 35% in West and Central Africa (Amadou et al., 2020; Pomati et al., 2020). Thus, such prevalence of malnutrition constitutes a critical limit for the expansion of developing countries, given the irreversible consequences of this pathology. Malnutrition is the cause of nearly half

(45%) of all deaths in children under five years of age (Park et al., 2012; Black et al., 2013). For WHO (2016), malnutrition is among the main causes of child mortality in Africa, and affects mainly the poorest countries.

In the literature on this subject, malnutrition is linked to children, their caregivers, and household characteristics in which they live. According to UNICEF Food for Health conceptual framework, contextual factors such as norms, food taboos, and cultural and religious beliefs are considered to be fundamental causes of malnutrition. These factors have also been discussed in the work of Martínez et al. (2013), Onyesom (2007), Zepro (2015), and Lepowsky (1985). Crépin et al. (2008), Ekwochi et al. (2016), Zepro (2015). Food taboos indeed influence the quantity, frequency, and quality of nutrients consumed by mothers and children and result in the depletion of vital nutrients. They often affect animal-based foods, which contain about 18% protein (Onyesom, 2007), thus influencing nutrient intake. They create dietary protein deficiency, often observed in pregnant and lactating women, the poor, the elderly, and children, especially in developing countries and rural areas.

Previous studies show that taboos are more respected in countries where malnutrition rates are still high. For example, the analysis by Oni et al. (2012) shows that 26% of pregnant women in Indonesia avoided fish, meat, vegetables, and chicken eggs. Similar dietary practices have been found among groups of pregnant women in India.

Indeed, Zepro's (2015) study in southern India shows that 63.7% of women avoid eating certain vegetables/fruits during pregnancy and do the same for their children. Similar behaviors are observed in Africa, where 36.5% of women in one region of Nigeria avoid certain foods for their children and during pregnancy due to attachment to food taboos (Ekwochi et al., 2016).

These high levels of food restriction or taboos in countries where malnutrition is still general raise questions: What factors determine whether or not households practice food restriction? What factors are significantly related to the choice of food taboos in families with stunted children? To answer these questions, the objective of this study is to determine the factors related to the choice of food taboos in households with stunted children in Bopa, a region in south- western Benin. Few studies have been explicitly conducted on families housing malnourished children and practicing food restrictions.. Moreover, the results will contribute to a burgeoning literature on malnutrition in food -restricted households.

This paper is organized into six sections. After an introduction, the next section presents a review of the literature dealing with the topic addressed in the paper. This section follows the estimation methodology, then the sections presenting the results and discussion, and the last section summarizes the main points and policy recommendations.

II. LITERATURE REVIEW

In recent decades, the literature has addressed the problem of chronic malnutrition because of its impact on the socio economic development of developing countries. It is associated with the child's social environment, the sociodemographic characteristics of the child's progenitors, the family's religious beliefs, and the community's social perceptions. Works of Deutz et al. (2019), and Fleurke et al. (2020) mention determinants of malnutrition, the child's environment, the household environment, the characteristics of the head of the household, and the mother's characteristics and practices about nutrition. Availability of health and socio- economic infrastructure, availability and diversity of food in the market, variety of livelihoods, and food consumption were listed as determinants of malnutrition by Groleau et al. (2014) and Srivastava (2014). The gender of the household head, household size, father's occupation, household income, mother's occupation, and gender of the child are explanatory factors for the presence of malnutrition in households (Akoto et al., 1988; AGVSAN 2009; Masibo et al., 2012; Wong et al., 2014; WFP 2018; Handa 2020).

Beliefs, values, and dogmas related to religious practices influence perceptions and determine, in part, the habits and behaviors of the faithful.

Indeed, this influence is due to the prohibition by religions on consuming certain foods. For example, Muslims and followers of Celestial Christianity do not eat pork; Hindus do not eat beef, which is revered, even though these foods are rich in protein and iron, which are essential for the body. For Indonesian women, for example, eating fish and other foods from a river would lead to difficulties in delivery because the fetus would be upside down in the womb, while eating chicken eggs would make them behave like chickens in childbirth and make it last longer (Oni et al., 2012). For the author, these choices are also influenced by religion in that community leaders generally impose cultural and traditional beliefs on women and children, which makes these populations vulnerable in most communities. In The Gambia, each clan called "kabilah" has certain food that its members are forbidden to eat. Partridge, vulture, guinea fowl, warthog, monitor, lizards, wolves, Gambian rats, squirrels, ducks, and monkeys were mentioned as food taboos in the study by Martínez et al. (2013).

The authors' analyses of The Gambia also indicate that pregnant women do not consume eggs, bread, bananas, catfish, or peanuts. Food taboos of the mother's clan are respected. This leads to a low protein and carbohydrate diet for both mother and baby. Termites, flying ants, crocodiles, and grasshoppers are not consumed by some households for ancestral reasons (Martínez et al., 2013). The practice is almost identical throughout African countries where malnutrition rates among pregnant women and children are still high.

In southern Nigeria, it is feared that a child who consumes meat and eggs becomes a thief as an adult (Onyesom, 2007). For these parents, children raised with meat and egg-based dietary habits will grow up to have expensive eating habits. The same author suggests that consuming cow's milk will make children behave as cows. While they will be intelligent if they consume coconut milk. And the consumption of animal liver will cause liver abscesses. Similar analyses were conducted in southern Nigeria in 2016 with the work of Ekwochi et al. (2016). For these authors, snail and grasscutter meat are frequently avoided foods during pregnancy in southern Nigeria, while eggs are avoided in children under the age of two. According to them, snails and grasscutter meat would make the child lazy. In some cultural areas of Nigeria, pregnant women must avoid eating snails otherwise, the newborn is exposed to excessive salivation and vomiting(Oni et al., 2012). Eating yam can make the new born fat and deliver pain. In addition, pork consumption may be a favorite spot for newborn skin (Ogbeide, 1974; Oni et al., 2012).

It's prohibited for young girls in Lesotho to eat eggs, because eggs would increase sexual desire and cause them to seek sexual intercourse (Martínez et al., 2013).

In Vanatinai custom, before weaning age, children must avoid eating animal protein, fruits, vegetables, store-bought foods, or any other sweet and fat foods (Lepowsky, 1985).

It's suspected that Adults and children will become seriously ill if they eat fish or shellfish. Farmers in these areas should not touch fish before planting yams; otherwise, the yams will disappear. Dogs are never eaten among the Vanatinai. Eggs, fish, and bananas are considered food taboos during pregnancy in other ethnic groups in Papua New Guinea and Nigeria (Martínez et al., 2013). Rakotosamimanana (2014) and Zepro (2015) conducted similar analyses on the practice of food taboos in Malagasy culture and Ethiopia, respectively. For Zepro (2015), the most frequent taboos in Ethiopia are related to the simultaneous consumption of milk and fruits, such as mango, orange, pineapple, and nuts. In Igarra, Delta and Owan regions of Benin, coconut milk and liver are not given to children (Ogbeide, 1974). Other localities such as Urhobo and Owan, pregnant women are forbidden to eat the larger mushrooms. Ika, Ishan, Urhobo, Midwest, and Wa localities of Benin, food taboos are related to the consumption of porcupines, fresh meat, palm

nut soup, snails, sheep, pigs, dogs, snakes, beans, and vegetables.

Overall, food taboos related to religious dogma, customs, and practices practiced by households are more detrimental to children, lactating women and other household members because they reduce the consumption of foods that are very rich in protein and vitamins. These restrictions create protein and vitamin deficiencies in children and lactating women, which are necessary for the proper growth of children.

Significant links have been established between food taboos and household socio economic and cultural factors. A connection has been found between health education and food taboos (Lepowsky, 1985). Martínez et al. (2013) identified a statistically significant relationship between religion and food taboos. Benkheira (1997), and Oni et al. (2012) found an association between food taboos and age, primigravida, lack of formal education, and monthly family income.

Oni et al. (2012) found that it is also possible that adolescent mothers are more likely to be influenced by mothers-in-law, husbands, who perpetuate cultural beliefs. Based on these individual and collective factors mentioned in the literature as determinants of food taboos as a source of chronic malnutrition in children, a methodological approach adopted to carry out the same analyses in Bopa.

III. MATERIALS AND METHODS

This contribution is based on the database of a survey conducted by the Groupe de Recherche en Anthropologie Appliquée (GRAnAp) in December 2020 in 40 villages of the commune of Bopa in southwestern Benin. It consists of socio-economic data collected from heads of households and anthropometric data from children. The database contains 558 families of which 498 have at least one child aged 0-59 months. families were selected using a two-stage cluster random sample.

In the first stage, a random draw from 40 villages was conducted. In the second stage, a random draw of 17 households was conducted per village. One child under the age of 5 is randomly drawn from each sampled household. In this study, we adopt a two-stage analysis methodology. Simple binary logit model helps to identify determinant factors of a household's food taboos. Some socio-economic, cultural and anthropometric variables that may determine the practice or not of food taboos in families are selected on the basis of the literature review.

These variables are, on the one hand, gender, average monthly income, marital status, level of education, and occupation of the head of household; on the other hand, occupation, level of education of the wife of the head of household, place of residence, and religion.

In the binary logistic regression, the dependent variable noted Y takes two possible modalities: 1 if the household adheres to food taboos, and 0 in the opposite case.

$P(Y = 1)$ respectively $P(Y = 0)$ is the a priori probability that $Y = 1$ (respectively $Y = 0$). Let us posit : $P(Y = 1) = F(X\beta)$ *et* $P(Y = 0) = 1 - F(X\beta)$ where F is a distribution function R on the interval $]0, 1[$, increasing in its argument and β a vector of parameters (to be estimated) associated to the vector X and of dimension $(L, 1)$ if the vector X is of dimension $(1, L)$.

The logit model is the one defined by :

$$P(Y = 1) = \frac{exp(Xi\beta)}{1+exp(Xi\beta)} \quad \text{and} \quad P(Y = 0) = \frac{1}{1+exp(Xi\beta)} \qquad (1)$$

The Logit model is defined by the following equation:

$$\text{tabou} = \alpha_0 + \alpha_1 * \text{sexe Chef} + \alpha_2 * \text{niveaustruc Chef} + \alpha_3 * \text{PROcm} + \alpha_4 * \text{instructionW} + \alpha_5 * \text{religion CM} + \alpha_6 * \text{milieu} + \alpha_7 * \text{Cage ChM} + \alpha_8 * \text{Revenu} + \mu_i \qquad (2)$$

Where α_0 is the constant term, α_i is the regression coefficients; μ_i is the error term and :

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Y_i Cage ChM is the dependent variable (taboo); CageChM is age category of the head of the family; milieu is place of residence; instructionW is level of education of the wife of the head of the household; PROcm is the profession of the head of the household; level of education of the head of the household; Revenu is average monthly income of the family; religionCM is the religion of the head of the family. These variables are selected on the basis of the literature and the Pearson dependency test.

The second step of the analysis aims to identify factors linking food taboo choice with households where malnourished children are leaving. The Karl Pearson χ^2 test of independence is used to confirm the relation between variables. Both analysis methods generated following results.

IV. RESULTS

Of the 498 children aged 0-59 months, 36.3% are stunted. Of the households with stunted children, 76.2% have food taboos, the proportions of which are shown in Table 1 below.

Table 1: Summary of food taboos

Food taboos	Proportion
snails	0,5%
fish	1,0%
palm oil, oil extracted from the palm nut	1,8%
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	3,9%
duck, hawk, pigeon, guineafowl, weavingbirds	4,4%
hedgehog, vegetable, dandelion, mouse, catfish, woloug bolovi, wonto, koukou gbo, bush rats, squirrel6	6,9%
snake, python	11,6%
sheep, dogs, cats, pigs, sheep, goats	69,9%
Grand total	100,0%

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 1 shows that among the 389 households adhering to dietary restrictions, about 92.8% have nutritional restrictions related to meat consumption, and 70% of the food taboos are associated with the consumption of mutton, dog, cat, pork, sheep, and goat meat. More than 5.7% have taboos associated with the consumption of plant foods, and 1% associated with fish consumption. Results of the model determining the explanatory factors for adherence to food taboos are presented in Table 2 below.

The characteristics of the head of the family, sex (p-value = 0.028), profession (p-value = 0.002), religion (p-value = 0.028), age ranking (p-value = 0.034), and the average monthly income (p-value = 0.033) have significant effects on whether or not the family adheres to a food taboo. Results show that average monthly income (Odds Ratio = 2.439) and religion (Odds Ratio = 1.127) determine families' food taboos in the. In addition, the profession of the head of the household (Odds Ratio = 0.922) has the same effect.

This result shows that the average monthly income is 2.16 times more likely to influence adherence to dietary restrictions or taboos than religion requirements. On the other hand, the sex of the household head has little influence on whether or not a food taboo is practiced in the household.

Table 2: Logit model results

Taboo	Odds Ratio	St.Err.	t-value	p-value	Sig
Place of residence	0.845	0.218	-0.65	0.513	
Gender of head of household	0.332	0.166	-2.20	0.028	**
Level of education of the head of the household	0.843	0.127	-1.13	0.259	
Profession of the head of household	0.922	0.024	-3.13	0.002	***
Level of education of the wife of the head of the household	0.965	0.165	-0.21	0.837	
Religion of head of household	1.127	0.062	2.19	0.028	**
Age category of household head	0.757	0.099	-2.12	0.034	**
Average Monthly Household Income	2.439	1.02	2.13	0.033	**
Constant	8.328	5.423	3.26	0.001	***

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

The factors determining the choice of a restriction or taboo food are presented in the table 3 below.

Table 3: Factors that explain the choice of food taboos

Variable	Pearson's Statistic	P-Value
Gender of head of household	12.84	0.0761*
Level of education of the head of the household	42.72	0.0034**
Occupation of the head of the household	223.16	0.0000***
Marital status of head of household	54.82	0.0001***
Mother Tongue of the head of the household	51.04	0.0049***
Level of education of the wife of the head of the household	32.48	0.0523*
Place of residence	23.09	0.0016
Religion of the head of the household	72.07	0.0027***

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Male household heads are relatively more favorable to the practice of taboos related to the consumption of snakes, pythons, hedgehogs, vegetables, dandelions, mice, catfish, bush rats, squirrels, ducks, hawks, pigeons, guinea fowl, weaving birds. At the same time, women are relatively more in favor of avoiding the consumption of mutton, dog, cat, pork, sheep, goat, palm oil, and oil extracted from palm nuts. Concerning the level of education of the head of the household, those with no education and those with primary education are relatively more favorable to the restriction of meat consumption. Farmers, artisans, and those with no occupation are more favorable to restricting the consumption of mutton, dog, cat, pig, sheep, goat, snake, and python. Wives with no education or primary education are more likely to restrict the consumption of mutton, dog, cat, pork, sheep, goat, and snake python meat. The restrictions are much more practiced by heads of households who follow the endogenous and evangelical religion. Conditions related to the consumption of snakes, pythons, sheep, dogs, cats, pigs, sheep, goats, ducks, sparrow hawks, pigeons, guinea fowl, and weaving birds are practiced a lot in the endogenous religion.

V. DISCUSSIONS

In the literature, pregnant and/or lactating women avoid certain foods that are critical to their health and that of the fetus or newborn. The works of Poh et al (2005) on pregnant and lactating women and children state the same.

Indeed, the works of these authors in China state that women are not allowed to eat vegetables and fruits (water-melon, pineapple, carambola, papaya, cabbage, watercress) during pregnancy and delivery because these foods are cold. According to these authors, seafood (squid, cockles, shrimp, and crab) and fish (tuna, sardine, and bilis) are also avoided by Chinese women during childbirth.. Several decades earlier, Colley

(1978) and Choudhry (1997) noted a restriction on the consumption of fruits and vegetables among pregnant Malay, Chinese and Indian women. The main justifications of these food taboos refer to the childbirth moment when women and newborns are extremely vulnerable. Because of this, women must have an appropriate diet in order to maintain the health of the nanny (Poh et al., 2005). Mohammed et al. (2019) also report that green chili, offal, and dark green leafy vegetables as well as other grains are often avoided by lactating women in Ethiopia. The work of Chege et al. (2015) further shows that the ban on vegetable consumption in some parts of Kenya is based on the belief that the land is only for grazing and as a result, vegetables are perceived as livestock feed. Riang'a et al. (2017) and Santos-Torres et al. (2003) also reported that pregnant and lactating women avoided meat and vegetables due to taboos in Kenya and Mexico, respectively.

In northeastern Madagascar, most taboos are associated with traditional Malagasy ecological and epidemiological knowledge (Golden et al., 2015). These authors linked food taboos to religious or cultural beliefs. According to local northeastern Madagascar belief, if one violates these taboos, automatic sanctions will occur as part of spiritual retribution (Golden et al., 2015).

This result justifies the perpetuation of taboos over time and space in Madagascar. According to Moriniaux (2008), food taboos are omnipresent in Asian religions such as Jainism and Buddhism. Indeed, the rules of Judaism require scrupulous respect for the animal, whatever it may be. Jains are not only vegetarians but also avoid eating roots because digging them up could inadvertently kill a worm or other underground animal. Similar prohibitions observed by Buddhists. The consumption of sheep is forbidden in ancient Egypt because of their familiarity and use in the agricultural economy (see sheep theology). In the farming world in ancient Egypt, sheep are called upon for field preparation: grazing, pulling for plowing, and organic fertilizer (Aufrère, 2016).

For Chakona et al. (2019), the foods which most frequently be avoided by pregnant women or young children in the Eastern Cape, South Africa are fish, potatoes, fruits, beans, eggs, and pumpkin. These foods have a high rate of proteins and carbohydrates. The reasons for avoiding these foods are rooted in cultural beliefs linking to problems that may affect the mother during childbirth, to health problems that primarily affect the child. Another interpretation is related to mis-conduct during adult age.

Oni et al. (2012), Zepro (2015), and Vasilevski et al. (2016) also found that factors such as age, education level, and socioeconomic status influence women's awareness of the importance of a balanced diet and healthy eating during pregnancy. Oni et al. (2012) and Getnet et al. (2018) showed that the likelihood of adhering to food taboos is higher among women from low-income families earning less than US$54.2 per month and found a significant effect of age category on adherence to food taboos. For them, adolescent girls adhere more easily to food taboos.

They also find that the low literacy level would substantially increase the tendency of sticking to food taboos compared to educated people. Codjoe et al. (2016) find a statistically significant association between age, religion, occupation, and level of education attained by the head of the household and the choice of foods consumed by the family.. As for Harris-Fry et al. (2017), they found an association between occupation and adherence to food taboos.

In sum, this study corroborates findings from previous work on both the types and determinants of compliance with these food taboos. These results are enriching a social doctrine based upon an econometric approach to identify the determining factors of food taboos.

VI. CONCLUSION

Over the past two decades, Benin's demographic health surveys have revealed a chronic malnutrition rate in the Mono department that is consistently above the national average. This study analyzes factors that explain respect to

dietary taboos or food restrictions. In addition, it explores factors that are statistically significantly related to the choice of dietary restriction in households housing children under five years of age affected by chronic malnutrition in southwest Benin. The data set is fed by socio-economic data collected from heads of households and anthropometric data on 498 children. Univariate and bivariate descriptive analysis and the binary logit model are the methods used. The findings show that 36.3% of children aged 0-59 months are stunted, 78.1% of households adhere to food taboos, and 76.2% of households with stunted children adhere to food taboos. The results of the binary logit model show that adherence to food taboos is statistically significantly dependent on the gender of the head of household, their occupation, religion, level of education, age category, and average monthly household income..

Similarly, the choice of a given food taboo by the household depends on the gender of the head of the household, their level of education, profession, marital status, mother tongue, religion, the level of education of their wife, and the area of residence.. The fight against stunting calls for a multisectoral approach that places religious leaders and the local elite at the center of the strategy.

Conflict of Interest Statement

The authors state that there is no conflict of interest.

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APPENDIX

Table 4: Results of chronic malnutrition

	Presence of chronic malnutrition	Absence of chronic malnutrition	Total
No food taboos	43	66	109
sheep, dogs, cats, pigs, sheep, goats	90	182	272
palm oil, oilextractedfrom palm nuts	3	4	7
fish	1	3	4
snake, python	21	24	45
snails	2	0	2
hedgehog, vegetable, dandelion, mouse, catfish, wolougbolovi, wonto, koukougbo, bush rats, squirrel	14	13	27
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	4	11	15
duck, hawk, pigeon, guineafowl, weavingbirds	3	14	17
total	181	317	498
Pearson Chi2 = 13.61 Prob = 0.0925			

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 5: Relationship between food taboos and place of residence

Taboos	Rural	Urban	Total
sheep, dogs, cats, pigs, sheep, goats	73	17	90
palm oil, oilextractedfrom palm nuts	1	2	3
fish	0	1	1
snake, python	18	3	21
snails	2	0	2
hedgehog, vegetable, dandelion, mouse, catfish, wolougbolovi, wonto, koukougbo, bush rats, squirrel	9	5	14
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	0	4	4
duck, hawk, pigeon, guineafowl, weavingbirds	2	1	3
Total	105	33	138
Pearson Chi2 = 23.09 Prob = 0.0016			

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 6: Relationship between food taboos and gender of the head of household

Taboos	Female	Male	Total
sheep, dogs, cats, pigs, sheep, goats	25	65	90
palm oil, oil extracted from palm nuts	2	1	3
fish	0	1	1
snake, python	3	18	21
snails	0	2	2
hedgehog, vegetable, dandelion, mouse, catfish, woloug bolovi, wonto, koukou gbo, bush rats, squirrel	0	14	14
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	0	4	4
duck, hawk, pigeon, guineafowl, weavingbirds	0	3	3
Total	30	108	138
Pearson Chi2 = 12.84 Prob = 0.0761			

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 7: Relationship between food taboos and education level Head of household

Taboos	No level	Primary	Secondary	Superior	Total
sheep, dogs, cats, pigs, sheep, goats	57	16	17	0	90
palm oil, oil extracted from palm nuts	2	0	1	0	3
fish	0	0	1	0	1
snake, python	10	6	4	1	21
snails	0	2	0	0	2
hedgehog, vegetable, dandelion, mouse, catfish, wolougbolovi, wonto, koukougbo, bush rats, squirrel	5	4	5	0	14
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	0	2	1	1	4
duck, hawk, pigeon, guineafowl, weavingbirds	1	0	2	0	3
Total	75	30	31	2	138
Pearson Chi2 = 42.72 Prob = 0.0034					

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 8: Relationship between food taboos and occupation of the head of household

Taboos	Farmer	Reseller /Dealer	Artisan	Driver	Teacher	Nurse Caregiver	Other	No	Total
sheep, dogs, cats, pigs, sheep, goats	45	5	28	2	2	0	3	5	90
palm oil, oil extracted from palm nuts	0	2	0	0	0	0	1	0	3
fish	0	0	0	0	0	1	0	0	1
snake, python	12	0	4	1	0	0	4	0	21
snails	0	0	1	0	0	0	1	0	2
hedgehog, vegetable, dandelion, mouse, catfish, woloug bolovi, wonto, koukou gbo, bush rats, squirrel	7	0	1	2	0	0	4	0	14
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	0	0	2	1	0	0	0	1	4
duck, hawk, pigeon, guineafowl, weavingbirds	1	0	0	1	1	0	0	0	3
Total	65	7	36	7	3	1	13	6	138
	Pearson Chi2 = 223.16 Prob = 0.0000								

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 9: Relationship between food taboos and marital status of the head of household

Taboos	Married monogamous	Marriedpolygamist	Common-law, Single	Divorced/ separated, Widowed	Total
sheep, dogs, cats, pigs, sheep, goats	63	26	1	0	90
palm oil, oil extracted from palm nuts	2	0	0	1	3
fish	1	0	0	0	1
snake, python	13	8	0	0	21
snails	1	1	0	0	2
hedgehog, vegetable, dandelion, mouse, catfish, woloug bolovi, wonto, koukou gbo, bush rats, squirrel	9	4	1	0	14
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	4	0	0	0	4
duck, hawk, pigeon, guineafowl, weavingbirds	1	2	0	0	3
Total	94	41	2	1	138
Pearson Chi2 = 54.82 Prob = 0.0001					

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

Table 10: Relationship between food taboos and the level of education of the head of household's wife

Taboos	No level	Primary	Secondary	Superior	Total
sheep, dogs, cats, pigs, sheep, goats	25	45	14	6	90
palm oil, oil extracted from palm nuts	2	0	0	1	3
fish	0	1	0	0	1
snake, python	3	12	4	2	21
snails	0	2	0	0	2
hedgehog, vegetable, dandelion, mouse, catfish, woloug bolovi, wonto, koukou gbo, bush rats, squirrel	0	8	3	3	14
okra, crincrin, redbean, fried corn, grilled corn, papaya, cassava, yam	0	0	3	1	4
duck, hawk, pigeon, guineafowl, weavingbirds	0	3	0	0	3
Total	30	71	24	13	138
Pearson Chi2 = 32.48 Prob = 0.0523					

Source: GRAnAp, Nut Aumed Survey, December 2020, authors

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Multimodality Treatment in Case of Peritoneal Mesothelioma – A Case Report and Review of Literature

Ali AL Sharqi, Samiya AL Kalbani & Rashid AL Alawi

ABSTRACT

Peritoneal mesothelioma (PeM) represents around one-fifth to one-third of all mesothe lioma. The incidence of PeM is approximately one per 1,000,000. Given the fact of non-specificity of the symptoms, the diagnosis is usually delayed.

Multimodality treatment with adjuvant chemotherapy, and cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) improves long-term survival. Herein; this is a presentation of a patient diagnosed with peritoneal mesothelioma with a review of the literature.

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Peritoneal mesothelioma (PeM) represents around one-fifth to one-third of all mesothe lioma. The incidence of PeM is approximately one per 1,000,000. Given the fact of non-specificity of the symptoms, the diagnosis is usually delayed.

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Keywords: peritoneal mesothelioma, cytoreductive surgery, chemotherapy.

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I. BACKGROUND

Malignant mesothelioma is a rare but fatal tumor that primarily arises from the pleura but to a lesser extent from the peritoneum (1). Peritoneal mesothelioma (PeM) represents around one-fifth to one-third of all mesothelioma (2). The incidence of PeM is approximately one per 1,000,000 (2,3). Similar to all types of malignant mesothelioma, PeM has an attributable risk with exposure to asbestos (4). The majority of patients with PeM present with abdominal distention with or without pain, weight loss, and some presents with ascites (2,3). Given the fact of non- specificity of the symptoms, the diagnosis is usually delayed (3). The survival rate of PeM was around 5 to 12 months, but since the introduction of cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC), long-term survival can be achieved (1,3).

II. CASE PRESENTATION

A 44 year old female with no significant past medical history presented with four weeks history of progressive abdominal distention and pain. This was not associated with nausea or vomiting, and no history of fever. She had never smoked and had no known previous exposure to asbestos.

The rest of the systemic review was unremarkable. On clinical examination, she was hemodynamically stable, had positive ascites with no palpable mass and no pedal edema but normal cardiovascular and respiratory system examinations. Laboratory investigation, including complete blood count (CBC), urea and electrolytes, liver function tests (LFTs), hepatitis, inflammatory markers, and viral and autoimmune screens, were all normal. She underwent a CT abdomen and pelvis, which showed massive ascites and omental nodular thickening with multiple scattered lymph nodes (Image 1A and 1B). Also, there were few hypodense liver lesions suggestive of hepatic cysts, and a large heterogenic enhancing mass in continues with the uterus, most likely representing subserosal leiomyoma. Diagnostic laparoscopy with an omental biopsy was performed. The histopathological examination showed epithelioid peritoneal mesothelioma. Ascetic fluids were taken for assessment; however, the sample was not enough. The case was discussed in the

multidisciplinary meeting, and the conclusion was to treat the patient with systemic chemotherapy and repeat CT for assessment of operability. She received neoadjuvant chemotherapy with a total of four sessions of Pemetrexed with carboplatin.

She responded well and the ascites resolved with improved general well-being. Computed Tomography repeated, and showed resolution of the once noted ascites, small residual omental peritoneal soft tissue nodularity and stable previously seen liver cysts and uterine mass. After that, she underwent Exploratory laparotomy + cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC). The intraoperative finding was no peritoneal deposits, peritoneal cancer index (PCI) of 12, multiple small deposits over the small bowel (Image 2), small liver cyst, and uterine fibroid. The histopathological examination of the omentum and soft tissue of the small bowel showed involvement by malignant mesothelioma, but a decrease in cellularity in comparison to the initial biopsy consisting of the chemotherapy response.

Then she had regular follow up with surgery and oncology departments, where she received adjuvant chemotherapy with the same neoadjuvant regimen where she had good response to the treatment in terms of clinical and radiological findings. A follow-up CT after surgery showed no evidence of intra-abdominal local recurrence or distant metastasis (Image 3)

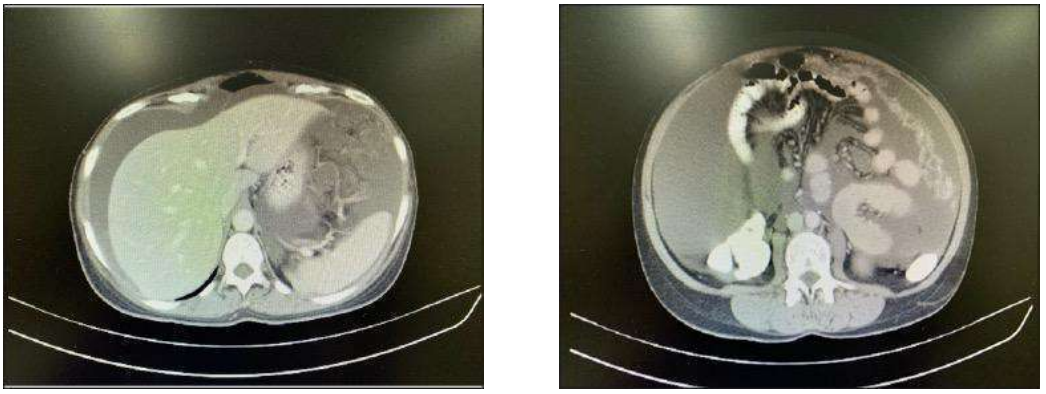

Image 1: Represents preoperative CT finding Image 1a: showing ascites with multiple liver cysts and Image 1b is showing the omental thinking with multiple lymphnodes

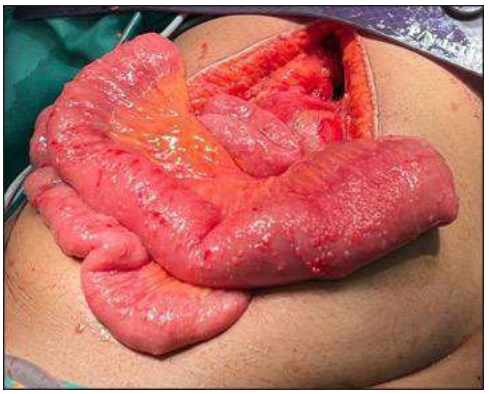

Image 2: Intra operative finding of multiple small deposits over over small bowel

Image 3: Post operative CT finding of resolution of the ascites and no evidence of local recurrence

III. DISCUSSION

Mesothelioma is a tumor that originates from the mesothelial surface lining cell of the serous cavity, with the pleural being the most commonly involved serosal membrane (3). Peritoneal mesothelioma (PeM) represents less than 10 % of malignant mesothelioma (4). In the old literature, cases of PeM were reported to have a poor prognosis with a median survival of less than one year whereas recent studies reported a median survival of 60-90 months (5,6).

The main risk factor for the development of malignant mesothelioma is a history of asbestos exposure. This risk is less prominent in the case of PeM compared to pleural mesothelioma (1). Other factors have also been implicated in the development of PeM, like radiation, peritonitis, and Simian virus 40 (SV40) (3,7). However, our patient had none of these risk factors.

The clinical presentation is usually not specific and poses a struggle and difficulty in the diagnoses. The most commonly reported symptoms and signs are; abdominal pain, abdominal distention, ascites, mass and tenderness (1,8). Imaging modalities like Ultrasonography and CT scan can provide essential information during the process of a mesothelioma diagnosis. However, to confirm the diagnosis of PeM, a histological examination is needed, which can be established through either open or laparoscopic surgery (2). The immunohistochemical analysis helps in increasing the diagnosis accuracy. Multiple Immuno-histochemical markers were linked to PeM, including; calretinin, epithelial membrane antigen (EMA), Wilms' tumor-1 protein (WT-1), antimesothelial cell antibody-1, cytokeratin 5/6, thrombomodulin and mesothelin. Also, tumor markers like CA – 153 and CA – 125 have been helpful in the diagnosis and monitoring of this disease (9,10). However, no immunohisto-chemical examination was done for our patient where the histological examination was enough to confirm the diagnosis.

The histopathological examination of this patient revealed epithelioid peritoneal mesothelioma. Different studies showed that epithelial PeM confers a more favorable prognosis and overall survival among different histological subtypes whereas the sarcomatoid and biphasic had the worst prognosis (13).

The staging peritoneal cancer index (PCI) is used as a measure of disease spread. Thirteen abdominal regions are used to score the PCI for tumor size and distribution. A lower PCI score is associated with a good prognosis (14). In the presented patient, the PCI was 12, which considered a low PCI score that might play a role in the excellent response to the treatment.

Over the last decades, the management of Peritoneal mesothelioma was evolving. With the multimodality treatment, including cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC), the median survival rate increased up to 60-90 months (5,6). In the present case, neoadjuvant chemotherapy was used as systemic therapy with four sessions before the CRS+HIPEC surgery, which showed a dramatic reduction in the size of mesothelioma deposits that were seen in the initial laparoscopic surgery for a biopsy. The standard first-line systemic chemotherapy is Pemetrexed with cisplatin or carboplatin (12). The same standard chemotherapy was used on our patient. However, multiple studies showed that using systemic chemotherapy does not increase the long-term survival rate but its benefit in palliative treatment and consider an alternative therapy for inoperable cases (11).

IV. CONCLUSION

The case highlighted the importance of keeping peritoneal mesothelioma a differential diagnosis in a patient who presents with ascites, even if it is uncommon. A multidisciplinary approach with multimodality treatment including Cytoreductive surgery with HIPEC and chemotherapyis needed for better outcomes in patinet with epithelioid histology.

V. DISCLOSURE

The authors declare no conflicts of interest. The consent from the patient was taken before writing up the case.

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Determinants of Complementary Foods Choice for Children in South West Benin

Guy Armand. Onambele & Laïfoya Moïse Lawin

ABSTRACT

The choice of complementary foods, especially for children aged 0-23 months, remains an issue in most parts of the world, particularly in developing countries. We examine in this paper the factors determining the choice of complementary foods for children aged 0-23 months in southwest Benin. The data comes from the UntAmed survey conducted by the Applied Anthropology Research Group (AARG) in December 2020. The study employed an unordered multinomial logit regression model and bivariate analyses. Through econometric models, results show that complementary foods are introduced early to children. The choice of complementary foods is dependent on average family income, mother's occupation, food taboos, number of economically active persons in the household, residence environment, family food consumption score, survival strategy adopted by the family and reduced coping strategy index. Policy sensitization targeting heads of family on food restriction, family income and women's education improvement, and nutritional education for women are key actions for complementary food choice for children.

Keywords: complementary food, chronic malnutrition, nutritional education, diet, food taboos, children, determinants.

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I. INTRODUCTION

Among the 17 Sustainable Development Goals to be achieved by 2030, promoting good health and well-being is as important as the fight against poverty and hunger. One of the factors to ensure this good health is the diet, the quality of which depends on the first complementary foods chosen for the infant before weaning.

Complementary foods are foods that are consumed or administered to supplement the regular diet and that are a concentrated source of nutrients or other substances that have a nutritional or physiological effect alone or in combination with other food. Brown et al. (2000) define complementary foods as the first foods (liquid or solid) introduced into the infant's diet in addition to breast milk. These foods aiming to complement a child's diet found insufficiency in daily intake. From the age of six months, breastfeeding alone is no longer sufficient to guarantee better growth and optimal health for children. WHO (2001) recommends that adapted complementary foods be introduced to children's diets according to their changing nutritional needs. However, some countries make their recommendations. In 2008, the European Society of Pediatric Gastroenterology, Hepatology and Nutrition published an opinion stating that while exclusive breastfeeding for the first six months was the ideal goal, the introduction of complementary foods was still possible from 17 weeks and not after 26 weeks in healthy, full-term children (Agostoni, 2008). Countries such as Germany, Belgium, and Spain, and the United Kingdom recommend the introduction of solid foods between four (4) and six (6) months (Bolling, 2007; Schiess, 2010; Schwartz, 2011).

The age of admission of supplemental foods for the child represents the transition period during which the infant is particularly vulnerable. This transitional period is a sensitive time during which nutritional influences would have long-term effects on the child's later development and

health (Moorcroft, 2011). It is also a high-risk phase in the lives of infants, as poorly conducted complementary feeding elevates multi-deficiency malnutrition to a critical health issue in infants (Azagoh-K. et al., 2013; Victora et al., 2016). Thus, several studies indicate that the early introduction of solid, semi-solid, or soft foods is a nontrivial problem globally.

Healthy eating patterns in childhood promote optimal childhood health, growth, and intellectual development (Garcia-Mufozet al., 2022). Whether solid, semi-solid or soft, the choice of food depends on many factors inherent to the mother, the head of the household, and environmental factors. In Bopa (south west Benin), mothers are confronted with economic and socio-anthropological constraints that are likely to influence the choice of food as well as the mode of feeding infants. This study is aiming to analyze factors that influence families in the choice of complementary foods for children over 6 months of age (the critical age for the introduction of complementary foods). The objective of this study is to analyze the determinants of the choice of complementary foods for infants in southwest Benin.

Food choice has the potential to influence our health, community, social status, and self-efficacy (Niamh et al., 2022). Following scientific rigor, the search for information related to the problem addressed in this paper was carried out within specific frameworks through documentary research in scientific journals. In these scientific journals, the literature related to children's nutrition was analyzed within four ways: (i) complementary feeding and weaning, (ii) exclusive breastfeeding, (iii) complementary feeding, and (iv) early or late introduction of complementary foods. For this study, we specifically address the determinants of the choice of complementary foods for the infant. Several studies indicate that complementary foods are introduced early into children. This is the case for Danish infants, with the work of Kronborg et al. (2015). Kronborg et al. (2015) highlight that during the first weeks of birth, 14% of Danish infants eat a family diet. This proportion increases to 32%, 43%, and 74% at 2, 4, and 6 months, respectively. They point out that by six months, 87% of infants had been introduced to solid food. In 1999, the WHO work indicated that in Benin, the introduction of complementary foods was also early, with a rate of 34% of children aged 2-3 months receiving the first foods. For the author, Cameroon shows almost the same percentage, 28% of children under four (4) months of age consume complementary foods. The trend is similar in Sub-Saharan Africa. However, recent studies point to some improvement in the age introducing complementary foods to children in Benin. Indeed, the Country Profile on Nutrition conducted by the FAO in 2011 shows a rate of 43% of exclusive breastfeeding before six (6) months for Benin.

In the literature, voices have been raised to highlight the disadvantages of the early introduction of foods for children. Up to the age of six months recommended by WHO and UNICEF, research has shown that exclusive breastfeeding is associated with continued protection against gastrointestinal infections and diseases (Kramer et al., 2003; Kramer et al., 2002) and also against respiratory tract infections (Chantry et al., 2006).

Similarly, the results of the work of Macy (1949), Kannan et al. (2004), and Edmond et al. (2006) demonstrate that up to 6 months, breastfeeding is more favorable to the health of the child than artificial milk of bovine or vegetable base.

According to the Diagnostic and Statistical Manual of Mental Disorders (DHS-IV), 50% of babies hospitalized for stunting without an identifiable medical cause suffer from feeding problems. Polan et al. (1991), Satter (1986), and Ward et al. (1993) indicate that feeding problems are caused by insensitive mothering and lack of interaction at mealtime. Physiological difficulties with the feeding process (appetite and intake), food refusal, tantrums, and difficulty sucking, swallowing, or chewing food have been highlighted by Reilly et al. (1999), Ramsay et al. 1993), Art-Rodas et al. (1998) as symptoms of eating disorders related to the early introduction of complementary foods in children. Early introduction of complementary foods also leads to malnutrition. In north western Nigeria, the

prevalence of malnutrition among children is high due to poor complementary feeding practices (Anigo, 2010).

In many parts of the developing world, complementary feeding remains a challenge for good child nutrition. Thus, the type of complementary foods are different from one country to another. In China, Wang et al. (2017) reveals that most nannies prefer soy-based complementary foods to children. In Africa, analysis by Trèche (2002) and Traoré et al. (2005) reveals that the primary complementary foods given to African children are cereal- based porridges sparsely fortified with local legumes (peanut paste or roasted soybean meal), milk, or dried fish powder. This analysis was confirmed in a region of Nigeria, with the work of Anigo (2010) showing that in north western Nigeria, supplementary foods are composed of maize, millet, and sorghum with groundnuts and soybeans. In the same logic, the work of Fanou Fogny et al. (2018) highlights the composition of the flour used to prepare porridge for children aged 6 to 23 months in Benin. The analysis shows that corn flour obtained from incorporation rates of 70% corn, 13% soy, 16% peanuts, and 1% fretins is preferred by 46% of women, while porridge obtained from corn flour alone is the least appreciated (18%).

In addition, studies have shown that supplemental foods given to children are low in essential micronutrients. Abeshu (2016) points out that in Ethiopia, commonly used complementary foods are homemade but do not provide enough key micronutrients (especially iron, zinc, and calcium) to children aged 6 and 23 months. Similarly, in Benin, Nago et al. (2018) provided the evidence that proteins provided by these complementary foods are only vegetable and very poor in micronutrients. They raised inadequacy/insufficient energy density of porridges made with certain flours and used by families to feed young children. These porridges can't make them grow properly.

A large body of literature has been devoted to analyzing the determinants of complementary food choices. For Noukpoape (1997), several factors influence children's complementary foods choice. These include the socio-occupational status, the educational level of the nanny, her standard of living (poverty), and her secular tradition in infant feeding. Godin's (2012) work mentions personal factors (e.g., age, gender, education level) and environmental factors (social and physical environment). Similarly, Lange et al. (2013) found that introducing complementary foods to child diets is determined by duration of exclusive breastfeeding, weaning age, individual characteristics such as mother's age, her education level, caregiver during weaning, and child's gender. According to their analysis, fruits and vegetables were the least accepted foods by children in the early weaning period. For Kronborg et al. (2015), the higher birth weight of the child, the older age of the mother, and education level are the factors that determine supplemental foods. Other works such as Wang et al. (2017) reveal that a mother's nutrition education influences the behavior in supplementation introduction and feeding quality and nutritional status of children aged 6-23 months. In addition, research has shown that the choice of complementary foods is related to the income and development level of the country. In low-income countries, most infants receive cereal-based complementary foods prepared at the household level (Amagloh et al., 2012) that are lower in iron, calcium, and zinc.

Akpaki's (2021) analysis of Senegal reveals a number of factors that influence feeding behavior among children. Psychosocial factors, community, and household food availability, and socio-economic status were the determinants of household food insecurity and children's choice of complementary foods. His analysis also highlights traditional constructs, education level, literacy level, and residence influencing food choice behavior.

Maternal knowledge of infant feeding practices influences feeding patterns and the choice of complementary foods for children. Diarra (2020) assessed the ability of mothers of children under five years of age about infant and young child feeding practices in the Bla health district in Mali in 2019. This study was carried out two years after

the implementation of a project that consisted of distributing Lipid Nutritional Supplements and counseling on breastfeeding and infant feeding.

Based upon findings, 96.5% of mothers introduce complementary foods to the child's diet in the age range of 10-12 months. When a child is malnourished, 66.5% of mothers give specific vitamin-enriched complementary foods.

Because of religious taboos, families are not allowed to consume backyard animals and certain vegetables, which influence the choice of supplemental foods for children.

The literature provides a broad explanation of food taboos and their impact on household consumption patterns.

In all known cultures, food prohibitions are more critical for animal products than plant products. This is because animals have attributes or morphological characteristics that make them much closer to human beings. This makes them the object of dietary restrictions (Fischler, 1995; Lambert, 1997). Religion also establishes dietary taboos and restrictions. We have illustrations in religious prohibitions. In Islam and Judaism pork consumption is not allowed. Same for the beef in Hinduism. Christians avoid eating meat some days(Poulain, 2007).

Beyond religious prohibitions, there are also individual and cultural aversions. The attitudes one has towards an animal or meat are determined by a cultural and social code that refers to representations of the animal. Leach's analysis (1972) goes into the same track : edibility and non-educability are the result of a "derivation". This author affirms that the food taboos are justified by the proximity between animal and human beings. Thus, in some cultures, eating animals is similar to creating social disorder between humans and nature. That is why socio-cultural distance must separate them. Nowaday, the decline in meat consumption is linked to sensitivity to realities such as death, suffering, violence, waste, and contamination of animals, which are increasingly known as beings close to humans (Fiddes, 1992). Some cultures have been and continue to be fundamentally vegetarian, either for ecological reasons, as is the case with the Amharas of Ethiopia, or for philosophical reasons (Hinduism).

Some cultures have been and continue to be fundamentally vegetarian, either for ecological reasons, as is the case with the Amharas of Ethiopia, or for philosophical reasons (Hinduism). In the same vein, Naloubèbouolè (2002) emphasizes the importance of food prohibitions for children in Dagara society. His analysis reveals, among other things, that meat, fish, sugar, honey, and eggs are moral, sociocultural, and socio-economic prohibitions that influence children's choice of complementary foods. To update the previous findings, the present work uses appropriate materials and methods to approach the subject.

II. MATERIALS AND METHODS

2.1 Data Source and Sampling Method

The data used are extracted from the databases of a survey conducted by GRAnAp. This survey was conducted from November 20 to December 11, 2020, in 40 villages from the commune of Bopa, in the Mono department of Benin. The data are collected from heads of households, mothers/ caregivers of children aged 0 to 23 months, and children under 59 months. The sample size is obtained by the formula:

$$n = \frac{[4*r*(1-r)*(deff*Rn)}{[(e)^2*(Pb)*n_h]}$$

Where:
n = required sample size, expressed in the number of households
Four = factor in reaching 95% confidence interval
r = prevalence of malnutrition in the Mono department ≈25.6% (EDSB 2018). (NB: The same baseline prevalence is assumed by default for Self-Medication due to a lack of similar quantitative work on the topic in the country)
Rn = factor needed to increase the sample size by 5% to account for the non-response rate
Rn=1.05
deff = design effect for the indicator = 1.232 for Mono
e = 6% : margin of error
Pb = proportion of children under two in the total population, Pb≈ 9.6%.
NH = average household size = 5

This formula gives a size n = 570.
Households were selected from a two-stage cluster random sample. In the first stage, 40 clusters were randomly selected from all villages.

In the second stage, 17 households were randomly selected per cluster. At the end of the survey, the total number of households surveyed was 558, including 137 in urban and 421 in rural areas. 82.97% of households were headed by men, 17.03% were women. 72.8% of mothers/childcare are staying with the head of the family, and 71.8% have a low level of education.

Of these, 37.9% are farmers, and 34.0% are shopkeepers. Moreover, 34.3% of nannies are under 24 years, 45.3% are over 30 years, 57.3% of the children surveyed are boys, and 42.7% are girls.

2.2 Unordered Multinomial Variables Model

In this paper, the dependent variable is an unordered category variable with eight possible categories or choices (1-Boiled; 2-Boiled and soup; 3-Boiled, soup and Milk; 4-Boiled and Other; 5-Boiled, and Milk; 6-Boiled, and Other; 7-Milk and 8-Other). The literature teaches us that the generalization of binomial models (logit, probit) to discrete variables with more than two modalities is made using multinomial models (several modalities). In the dichotomous logit model, only one parameter vector β was needed to determine the two probabilities since Pr(Yi = 0) + Pr(Yi = 1) = 1. In the multinomial case, one needs a different parameter vector βj for each alternative. In general, for a multinomial logit model with m+1 modalities, one estimates m probabilities:

$$P_j = \Pr Pr\,(X) = \frac{exp(X\beta j)}{1+\sum_{k=1}^{m} exp(X\beta_k)}$$; for j = 1,2, to m and

a reference probability p

$$P_o = \Pr Pr\,(X) = \frac{1}{1+\sum_{k=1}^{m} \exp exp\left(X\beta_k\right)} \text{with} \sum_{j=0}^{m} p_j = 1$$

Another fundamental characteristic of the multinomial logit is the independence from other events of the ratio of the two probabilities associated with two possibilities, j and i

$$\frac{P_j}{P_i} = \frac{\Pr Pr\,(X)}{\Pr Pr\,(X)} = exp(X(\beta j - \beta i))$$

This implies that $\frac{P_j}{P_0} = \frac{Pr(y=j|X)}{Pr(y=0|X)} = exp(X\beta_j)$

It is assumed that this ratio is independent of possibilities other than j and i. This assumption is called the Independence of Irrelevant Alternatives.

The estimation of the parameters of the model is performed using the algorithms of maximization of the log-likelihood function. The values of the coefficients are not directly interpretable in terms of marginal propensity; only the signs of the coefficients indicate whether the variable has a positive or negative effect on the relative probability of choosing j rather than 0. The estimation results are assessed in the same way as for the other models:

- the significance of the coefficients using the z-statistic ratios,
- the overall significance of the fit (the hypothesis: H0: $a_1 = a_2 = a_3 = \ldots = a_k = 0$) by the statistic LR = -2(Ln(LR) - Ln(LU)) which follows, under the null hypothesis H0, a distribution of a χ2 with k degrees of freedom. The pseudo-R2 is given by: R2 = 1 - Log(Lu) Log(LR).

III. EMPIRICAL RESULTS

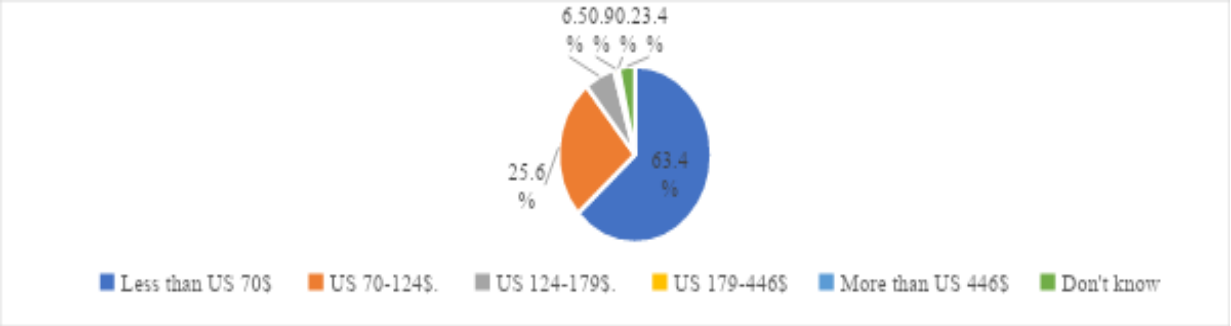
3.1 Univariate Descriptive Analysis

Analysis of Figure 1 shows a disparity or inequality in average household income. Indeed, nearly 90% of the surveyed population earn less than US 124$ average income per month. The statistics also show that approximately 85% of heads of household earning US 124$ work in the informal sector, and more than 40% are farmers.

We also note that 6.5% declare having an average income of US 124-179. In addition, the majority of heads of households with an average income of more than US 446 are civil servants and retirees.

About the number of economically active persons in the family, the survey data showed that a marginal proportion (3.5%) of households have no financially active persons. In comparison, 86.3% have at least two financially active persons, and

10.2% of households have at least three financially active persons.



Source: Nut Aumed/GRAnAp survey, December 2020

Figure 1 : Proportion of households by monthly average income groups

The staple foods consumed in these households are mainly processed into pastes or purees. Thus, maize and maize flour paste are widely consumed, which justifies the first food habit of these households. The statistics show that the most common primary food habit in the commune of Bopa is corn (96.8%). Cassava and beans are the second most consumed foods, with rates of 32% and 25.9%, respectively. Thus, we note that the overall diet of households in the commune of Bopa is based on roots/tubers (cassava, yams) and cereals (corn). According to this study, 41.8% of households have a high dietary diversity score (5-12 food groups), while 34.2% and 24.0% of households have a borderline and poor food consumption score, respectively.

For supplemental foods for children, Table 1 below provides an overview of the choices.

Table 1 : The proportions and numbers of households according to the type of complementary foods adopted

	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
Total	203	178	21	14	20	36	1	10	483
Frequency	42,0%	36,9%	4,3%	2,9%	4,1%	7,5%	0,2%	2,1%	100%

Source: NutAumed/2ARG survey, December 2020

The analysis of this table shows that the complementary food given to children under two years of age is mostly porridge; 42% of the nannies gave only porridge as a complementary food to their children, while 0.2% gave only milk. 97.7% of the nannies included porridge in their complementary foods. The age at which these foods are introduced varies from one nanny to another. Table 2 shows the distribution of nannies according to the average age of introducing complementary foods to the child.

Table 2 : Average age of supplementary feeds admission

Age	Frequency (%)
3 months	9,32
6 months	66,87
9 months	12,01
12 months and more	11,80
Total	100,00

Source: NutAumed/2ARG survey, December 2020

Analysis of Table 1 reveals that more than ¾ of foster mothers integrate a family menu with the child during the first six months of birth. Less than 10% of mothers reported combining supplemental foods during the first three months.

This rate has improved significantly from the 1999 situation, with WHO research indicating that in Benin, the introduction of complementary foods is early, with 34% of children aged 2-3 months receiving the first foods. For about 12% of nursing mothers, it takes at least 12 months before introducing complementary foods to the child.

The early introduction of complementary foods to children is based on the belief that the breast alone is insufficient. In this analysis, the majority of households have a food taboo. More than 70% of households avoid eating mainly red or white meats (beef, goat, poultry, pork, egg, and fish).

This custom is limiting children's access to the most nutritious micro-nutrients. Similarly, in this area, 6% of households remove vegetables and leaves, cereals and fruits from children's diet.

IV. BIVARIATE ANALYSIS

Table 3 in annex 1 shows Chi2 test results. The survey findings indicate that poverty and low household purchasing power make it difficult for households to afford appropriate complementary foods with high nutritional value for children. The test of dependence between the choice of complementary foods and the average income level of households confirms these statements. Indeed, the chi2 statistic for this test is 71.9561, with probability Pr = 0.000 (Table 3).

This result means that the likelihood of being wrong that the choice of complementary foods does not depend on the average household income level is almost zero. Households with an average monthly income of US $ 124 or less are the ones who introduce complementary foods into their infant's diet the earliest. This trend is confirmed by Amagloh et al. (2012).

Other factors showed their influence on the choice of complementary foods for children under two years of age in the commune. A chi2 of 100.7893 and a probability Pr = 0.000, confirms the dependence between the choice of complementary foods and the occupation of the child's mother (Table 3). The majority of mothers who are giving only boiled food as a complementary food are farmers, dealers, and craftswomen. Nevertheless, nurses recommend a mixture of boiled food, soup and milk. The choice of complementary food also depends on the number of economically active people in the household (chi2(35) = 52.2128; Pr = 0.031). In families where mothers give to children a mixture of boiling food, soup and milk or any other complementary foods are hosting at least two economically active persons. On the other hand, boiling and soup are complementary foods in households where there are less than two economically active persons.The analysis also shows that dietary restrictions (dietary and religious taboos) affect the choice of complementary foods for children in the commune of Bopa. Over half of households where red meat (beef, goat, poultry, pork, eggs and fish) are food taboos, complementary food chosen are boiling and or soup.

Furthermore, the choice of supplement depends on several other factors, such as the household food consumption score (chi2 = 71.3875; Pr = 0.000), the reduced coping strategies index (chi2 = 50.7461; Pr = 0.000), and the livelihood strategy adopted by the household (chi2= 55.9440; Pr = 0.000) (Table 3). Nearly 70% of those who choose only boiling and or soup have a poor or borderline food consumption score. On the other hand, those who supplemented boiling and soup with other vitamin and protein-rich foods (rice, beans, bananas, cookies, yogurt, yams, eggs, and fruits) were predominantly in households with acceptable food consumption scores. The statistics show that more than 70% of those who choose only boiling and or soup have adopted at least one livelihood strategy, while those who supplement cooking and soup with other vitamin and protein-rich foods have no strategy or have at most stress.

It is important to note that further analysis showed that some of these factors are in turn dependent on other factors. Indeed, the average family income depends on the occupation of the head of the household. The mother's occupation depends on her education level and on her husband, her age group, and the area of residence. The number of economically active persons in the household depends on the size of the family.

V. MULTIVARIATE ANALYSIS

This section examines the factors that influence the choice of supplement foods for children aged 0-23 months. In addition to the descriptive statistics that perform, a multinomial logistic regression model has been used to estimate the probability of choosing a supplemental food for the child. Table 4 provides a summary of the results obtained. Complementary foods mentioned are: pasta, corn paste, rice, beans, banana, cookies, yam yogurt, egg, and fruits.

The reference category chosen is the category composed of porridge and milk. The results show that the choice of porridge as a complementary food is influenced by the food consumption score, the livelihood strategy adopted by the household, the reduced coping strategy index, food taboos, the average household income, the area of residence, and the mother's occupation. For porridge + soup, we note that the choice of this category is influenced by the reduced coping strategy index, the average household income, the area of residence, and the mother's occupation.

The choice of the category composed of porridge + soup + others (pasta, corn paste, rice; beans, banana, cookies, yam yogurt, egg, fruit) is influenced by the reduced index of coping strategies, food taboos, average household income, and mother's occupation. On the other hand, the other category (composed of pasta, corn paste, rice; bean, banana, cookies, yam yogurt, egg, and fruit) is determined by the reduced coping strategies index and the average household income.

According to the regression coefficients assigned to the explanatory variables and the order ratios show that the food consumption score, the coping strategy adopted by the household, and the mother's occupation decrease the probability of choosing porridge + milk for the child than choosing only porridge. By the way, the reduced coping strategy index, average household income, and area of residence increase the probability of choosing porridge + milk for the child than choosing porridge alone as a complementary food for the child. Similarly, the reduced coping strategy index, average household income, and environment increase the probability of choosing porridge + milk as a complementary food for the child than choosing porridge + other as a complementary food for the child.

VI. DISCUSSIONS

The survey results indicate that complementary foods are introduced to children aged 0 to 23 months in the commune of Bopa. More than 3/4 of children receive complementary foods before six months. This result supports the results of work by made Brown et al. (2000), Bolling (2007), Schiess (2010), Schwartz (2011), Agostoni (2008), Moorcroft (2011), Azagoh- K. et al. (2013), and Victora et al. (2016). This early introduction of foods is causing sometimes gastrointestinal diseases (Kramer et al., 2003; Kramer et al., 2002), respiratory tract infections (Chantryet al., 2006), eating disorders (Polan et al., 1991; Satter, 1986; Ward et al., 1993; Reilly et al., 1999; Ramsay et al., 1993; Art-Rodas et al., 1998) and malnutrition (Anigo, 2010). These supplementary foods are usually made from cereals and contain little nutritional substance. The study shows that 42.0% of mothers give only porridge as a complementary food, 36.9% give porridge + soup, and 4.3% give porridge + soup + milk. Such a composition of complementary food for children is in line with the analyses made by Trèche (2002), Traore et al. (2005), and Fanou Fogny et al. (2018) in the case of African countries and those made by Anigo (2010) in the case of north western Nigeria. This result also supports the analysis of Nago et al. (2018) in the case of Benin.

The literature shows that several factors are drivers of the choice of complementary foods for children. The choice of complementary foods for children aged 0-23 months is influenced by average household income, place of residence, mother's occupation, food and religious taboos, food consumption score, livelihood coping strategy and reduced coping strategy index, which in turn are influenced by their determinants. Roisin Gallagher et al. (2022) recently indicate that attitude, control and social norms determine the intention to consume the perceived inedible parts of fruits and vegetables. Of all these constructs, attitude has the strongest impact on

intention, followed by perceived behavioral control and social norms. The results also show that perceived edibility, sustainability, and health benefits have a positive and significant impact on attitudes toward the perceived inedible parts of fruits and vegetables.

Other findings were shared by several researchers. In their analyses, Noukpoape (1997) and Hadi (2020) refer to the socio-professional situation, the educational level of the nanny, and her standard of living (poverty). Godin (2012) mentions personal and environmental factors (social and physical environment). Lange et al. (2013) mention individual characteristics (mother's age, education level, caregiver during weaning and child's gender), and duration of exclusive breastfeeding. For Kronborg et al. (2015), higher birth weight of the child, the older age of the mother, and education level influence the choice of complementary foods. The work of Amagloh et al. (2012) indicates the influence of income level on the selection of complementary foods. The result of Naloubèbouolè (2002); Fiddes (1992), Poulain (2007), Leach (1972), Fischler (1995); Lambert (1997) who similarly emphasized the determining role of religious and cultural taboos in the choice of complementary foods for children. Other factors such as the mother's nutritional education (Wang et al., 2017; Diarra, 2020), and psychosocial aspects of the mother Akpaki (2021) have also been mentioned in the literature.

Findings provide the factors that influence the choice of complementary foods for children in Bopa and complement the existing literature.

The results of these dietary patterns corroborate with the work of Séhonou et al. (2019) and Fanou Fogny et al. (2018) in the case of Cotonou. Anne Walsh et al. (2015) noted that complementary foods help infant weight gain, sleep patterns, and enjoyment at mealtime. Delpech (1995) points out in his review that complementary foods introduced to children are often deficient in protein and have more disadvantages than advantages. But, they expose the child to risks of contamination; on the other hand, intensive force-feeding can lead the child to wean himself. A turn to the literature teaches us that food taboos constitute a dietary restriction for mothers and then for children can be an influential factor in the choice of complementary foods.

The multinomial model used to approach this complex subject present work is bringing an added value for social analysis. It helps to highlight the presence of the number of economically active persons in the household, the reduced index of coping strategies and the subsistence strategy adopted by the household as the main drivers of complementary foods choice for children.

V. CONCLUSION

This paper is aiming to analyze the determinants of complementary food choices among households hosting stunting children in the commune of Bopa. Using a two-stage design with cluster sampling representative of the population of Bopa, this study collects anthropometric constants from children in the sampled households. It collects socio-economic data and dietary habits of the heads of families, mothers/caregivers. To achieve this goal, bivariate analysis and multivariate logistic regression models were used to analyze data. . The bivariate analysis consists of a Chi2 test of dependence between variables.

The results of this study generate a few key findings. First, foster mothers introduce complementary foods to children early (more than ¾ of children receive complementary foods in the first six (6) months after birth). Second, the choice of complementary foods depends significantly on average household income, mother's occupation, food taboos, number of economically active persons in the household, residence setting, food consumption score, livelihood strategy adopted by the families, and reduced coping strategies index. The multinomial model helps to confirm these factors.

We recommend implementing policy patterns targeting which can raise household awareness on food restriction, improve household income levels, improve women's educational levels, and provide vocational skills focused on women empowerment. Means to be used toward this goal

are microfinance projects increasing welfare, nutritional education targeting nursing mothers improving in the commune.

However, this paper has some limitations. The use of systematic sampling in the registers of health facilities for the recruitment of pregnant and lactating women, malnourished children under treatment, and the heads of households in which they live proved unproductive. This creates a minor discrepancy between the intended and covered sample. Anthropometric data were collected on only one child under five years of age per sampled household for logistical reasons. Nevertheless, they provide trends in the nutritional status of children under five years of age in Bopa.

In the future, a national or regional survey can be conducted to analyze the risks of early supplementary foods on malnutrition in children.

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Annexes

Table 3: Chi 2 results

	Choice of child's supplementary foods by average household income								
	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
Less than US 70$	148	95	15	6	16	20	0	4	304
70 - US 124$	41	58	5	5	4	9	0	5	127
124 - US 179$	6	18	1	3	0	5	0	0	33
179- US 446$	1	2	0	0	0	0	0	0	3
More than US 446$	1	0	0	0	0	0	0	0	1
DK	6	5	0	0	0	2	1	1	15
Total	203	178	21	14	20	36	1	10	483
Pearson chi2(35) = 71.9561 Pr = 0.000									
Choice of supplemental child support by mother's occupation									
	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
Farmer	81	52	2	4	3	10	0	1	153
Reseller Shopkeeper	45	45	6	1	3	8	1	0	109
Artisan	49	46	8	7	6	13	0	4	133
Teacher	0	1	0	0	0	0	0	0	1
Nurse / Caregiver	0	0	2	0	0	0	0	1	3
Professional/ Public servant	1	0	0	0	0	0	0	0	1
Other	9	0	1	0	1	0	0	0	11
No	18	34	2	2	7	5	0	4	72
Total	203	178	21	14	20	36	1	10	483
	Pearson chi2(49) = 100.7893 Pr = 0.000								
Choice of complementary foods for children according to food taboos									
	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
No taboos	57	25	4	8	2	11	0	5	112
Corn, corn porridge, rice, sorghum, millet paste, bread and other cereals	6	2	0	2	0	1	0	0	11
Beans, peas, peanuts and cashews	1	1	0	1	0	0	0	0	3
Vegetables and leaves	5	8	0	0	0	0	0	0	13
Fruits	1	3	0	1	0	0	0	0	5
Beef, goat, poultry, pork, eggs and fish	132	139	17	22	12	8	1	5	336
Oils, fats and butter	1	0	0	2	0	0	0	0	3
Total	203	178	21	36	14	20	1	10	483
	Pearson chi2(42) = 59.8409 Pr = 0.036								
	The choice of the complement depends on the number of economically active persons in the household								
Number of economically active persons in the household	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
0	6	7	1	2	0	1	0	0	17
1	57	52	3	4	3	6	1	5	131
2	118	106	17	20	11	11	0	3	286
3	16	11	0	8	0	2	0	0	37
4	4	2	0	2	0	0	0	2	10
5	2	0	0	0	0	0	0	0	2
Total	203	178	21	36	14	20	1	10	483
	Pearson chi2(35) = 52.2128 Pr = 0.031								

	The choice of supplement depends on the household food consumption score.								
	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
Poor food consumption	78	33	2	0	4	1	0	0	118
Food consumption limit	73	61	14	6	4	11	1	2	172
Acceptable food consumption	52	84	5	8	12	24	0	8	193
Total	203	178	21	14	20	36	1	10	483
	Pearson chi2(14) = 71.3875 Pr = 0.000								
	The choice of complement depends on the reduced index of coping strategies								
	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled and other	Boiled and Milk	Boiled and other	Milk	Other	Total
0 à 3	117	137	19	7	18	16	0	4	318
4 à 18	26	17	2	3	2	7	1	3	61
19 and over	60	24	0	4	0	13	0	3	104
Total	203	178	21	14	20	36	1	10	483
	Pearson chi2(14) = 50.7461 Pr = 0.000								
	The choice of supplement depends on the livelihood strategy adopted by the household								
	Boiled	Boiled and Souped	Boiled, Soup and Milk	Boiled Soup and others	Boiled and Milk	Boiled and other	Milk	Other	Total
No strategy	99	83	7	6	11	8	0	4	218
stress	65	54	12	1	1	14	0	5	152
crisis	22	25	1	1	6	8	0	1	64
emergency	17	16	1	6	2	6	1	0	49
Total	203	178	21	14	20	36	1	10	483
	Pearson chi2(21) = 55.9440; Pr = 0.000								

Source: NutAumed/GRAnAp survey, December 2020; Authors' calculations

Table 4: Choice of child's supplementary foods by average household income

Categorical dependent variable	Explanatory variables	Coef	Relative-Risk-Ratio(RRR).	P-Value	Sig
Boiled	Food consumption score	-1.211	0.298	0.001	***
	Livelihood strategy adopted by the household	-0.519	0.595	0.077	*
	Reduced index of coping strategies	1.959	7.094	0.003	***
	Food taboos	0.391	1.479	0.081	*
	Number of economically active persons in the household	-0.067	0.935	.843	
	Average household income	1.484	4.409	0.006	***
	Place of residence	1.09	2.973	0.009	***
	Mother's occupation	-0.122	0.885	0.032	**
Boiled and Souped	Food consumption score	-0.55	0.577	0.136	
	Livelihood strategy adopted by the household	-0.123	0.884	0.666	
	Reduced index of coping strategies	1.194	3.302	0.072	*
	Food taboos	0.363	1.438	0.104	
	Number of economically active persons in the household	-0.275	.76	0.41	
	Average household income	1.542	4.675	0.004	***
	Place of residence	0.785	2.193	0.057	*
	Mother's occupation	-0.099	.906	0.075	*
	Food consumption score	-0.554	0.574	0.231	

Boiled, Soup and Milk	Livelihood strategy adopted by the household	-0.063	0.939	0.862	
	Reduced index of coping strategies	0.05	1.051	0.956	
	Food taboos	0.224	1.251	0.384	
	Number of economically active persons in the household	0.027	1.027	0.951	
	Average household income	0.838	2.312	0.194	
	Place of residence	-0.084	0.919	0.871	
	Mother's occupation	-0.052	0.949	0.474	
Boiled Soup and others	Food consumption score	-0.083	0.92	0.875	
	Livelihood strategy adopted by the household	0.331	1.392	0.383	
	Reduced index of coping strategies	1.5	4.483	0.043	**
	Food taboos	0.408	1.503	0.093	*
	Number of economically active persons in the household	-0.623	0.536	0.185	
	Average household income	1.428	4.171	0.016	**
	Place of residence	-0.764	0.466	0.179	
	Mother's occupation	-0.19	0.827	0.026	**
Boiled and other	Food consumption score	-0.013	0.987	0.975	
	Livelihood strategy adopted by the household	0.048	1.049	0.884	
	Reduced index of coping strategies	1.743	5.715	0.011	**
	Food taboos	0.375	1.455	0.104	
	Number of economically active persons in the household	-0.077	0.926	0.841	
	Average household income	1.386	3.997	0.013	**
	Place of residence	-0.625	0.535	0.19	
	Mother's occupation	-0.191	0.826	0.005	***
Milk	Food consumption score	-0.548	0.578	1	
	Livelihood strategy adopted by the household	10.116	24741.29	0.99	
	Reduced index of coping strategies	-7.373	0.001	0.997	
	Food taboos	-0.123	0.884	1	
	Number of economically active persons in the household	-7.407	0.001	0.996	
	Average household income	7.172	1302.083	0.985	
	Place of residence	-24.142	0	0.989	
	Mother's occupation	-1.851	0.157	0.997	
Other	Food consumption score	0.045	1.046	0.935	
	Livelihood strategy adopted by the household	-0.885	0.413	0.108	
	Reduced index of coping strategies	2.204	9.059	0.004	***
	Food taboos	-0.008	0.992	0.98	
	Number of economically active persons in the household	-0.522	0.593	0.301	
	Average household income	1.236	3.44	0.045	**
	Place of residence	-0.603	0.547	0.323	
	Mother's occupation	-0.074	0.928	0.371	
	*** p<0.01, ** p<0.05, * p<0.1				

Source: NutAumed/GRAnAp survey, December 2020; Authors' calculations

Iron Overload in Bone Marrow Transplant Recipients in two Brazilian Centers: An analysis Based on Ferritin and Transferrin Saturation

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ABSTRACT

Background: Hematopoietic Stem cell Transplant Recipient conditioning regimens include immunosuppressive and myeloablative drugs that cause secondary cell damage and lead to ineffective erythropoiesis, which is one of the mechanisms that triggers iron (Fe) overload (IO). In addition, exogenous Fe from transfused blood components, specifically red blood cells, is what most contributes to excess Fe in the body. Fe toxicity secondary to transfusion is complex to estimate as it is related to the sum of exposure time and exogenous Fe associated with the factors determined based on the environment, genetic metal transport differences, and intrinsic antioxidant defenses.

Keywords: ferritin, iron overload, hematopoietic stem cell transplant, transferrin saturation, transfusion complications.

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Background: Hematopoietic Stem cell Transplant Recipient conditioning regimens include immunosuppressive and myeloablative drugs that cause secondary cell damage and lead to ineffective erythropoiesis, which is one of the mechanisms that triggers iron (Fe) overload (IO). In addition, exogenous Fe from transfused blood components, specifically red blood cells, is what most contributes to excess Fe in the body. Fe toxicity secondary to transfusion is complex to estimate as it is related to the sum of exposure time and exogenous Fe associated with the factors determined based on the environment, genetic metal transport differences, and intrinsic antioxidant defenses.

Objective: This study aimed to assess the impact of IO on HSCT in terms of overall survival (OS), in addition its relationship with red blood cell transfusion support, using serum biomarkers as ferritin and transferrin saturation.

Materials and Methods: A specific laboratorial and clinical data was collected in a sample of 199 bone marrow recipients from two public hospitals at São Paulo, Brazil, in a large period, submitted to allogeneic Hematopoietic stem cell transplantation, between 1996 to 2018.

Results: Data analysis showed that the highest mean ferritin levels in absolute numbers was reached within 100 days after HSCT in 146 (73.4%) patients, followed by a second peak in the ferritin levels in 44 (22.3%) patients 1 year after HSCT, with significantly decreased ferritin levels obtained in subsequent measurements. The sample presented higher TSI 100 days post-transplant, with a mean TSI of 46.93%. This finding correlates with the higher peak ferritin concentration in the same post-transplant period. OS was impacted by the number of red blood cell transfusions; the group with the lowest number of transfusions (<10) achieved greater survival. The study also demonstrated that a mean ferritin level of >1,000 post-HSCT impacted the patient's OS (79% versus 91%; p<0,05). We demonstrated that patients with a TSI of >50% have a lower OS, especially when evaluated after 1 year (80%: TSI > 50% versus 92%: TSI < 50%, p < 0.05). Conclusion: High ferritin and TSI levels cannot be attributed only to transfusion dependence, highlighting that the ferritin level remains high for up to 5 years, even if hemotherapy support is not required. Others factor must be evaluated in further studies to elucidate other mechanisms responsible for iron overload in bone marrow transplantation field.

Keywords: ferritin, iron overload, hematopoietic stem cell transplant, transferrin saturation, transfusion complications.

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I. INTRODUCTION

Hematopoietic stem cell transplantation (HSCT) is a therapeutic procedure involving the intravenous infusion of hematopoietic stem cells (HSCs) obtained from the blood of a previously selected donor into a properly conditioned recipient with the aim of reconstituting the hematopoietic organ. Recipient conditioning regimens include immunosuppressive and

myeloablative drugs that cause secondary cell damage and lead to ineffective erythropoiesis after transplantation, which is one of the mechanisms that triggers iron (Fe) overload (IO).[1,2,3] In addition, the recipient's previous transfusion history is a factor of great importance.

Exogenous Fe from transfused blood components, specifically red blood cells, is what most contributes to excess Fe in the body. The need for transfusion prior to transplantation depends on the underlying disease and varies; however, some diseases require frequent transfusion of blood products, especially those in need of myeloablative chemotherapy, such as acute leukemias and myelodysplastic syndromes.[4] In these cases, the patient undergoes repeated transfusions over a short period, which causes secondary Fe excess and leads to IO immediately before HSCT.

Fe toxicity secondary to transfusion is complex to estimate as it is related to the sum of time ($\Sigma^{time} \times \Delta Time$) of exposure to the reactive iron modulated by environmental and genetic antioxidant factors. This relation is highly nonlinear, making it impossible to predict iron toxicity from iron levels alone. Therefore, ferritin is intracellular but can leak into the plasma when cell membranes are damaged,and can be a useful marker. Thus, serum/plasma ferritin levels are a rough measure of iron loading, but are also sensitive to inflammation and cell membrane leak.

Hemosiderin, which is made up of aggregates of ferritin, is the primary species that is detected by MRI. (reviewed in Coates[5]).

IO diagnosis is suggested in patients with a serum ferritin level of >1,000, evidenced by transferrin saturation index (TSI) values of >50% in men and >45% in women.[6,7] In the context of HSCT, IO is diagnosed by liver biopsy, the gold standard test; however, it is not frequently used in the clinical setting due to its prohibitive risks. IO can also be verified by abdominal magnetic resonance imaging using the T2* protocol, but this test only shows the installed cell damage, estimating the direct quantification of the amount of Fe deposited.

Serum Fe levels, its cellular deposit (ferritin), and the indirect quantification of excess metal in transport (TSI) are used in the early serum IO analysis and in the continuous assessment of Fe metabolism dynamics. These data provide a broad picture of IO prior to HSCT and in periods of greater catabolism, such as after transplantation.

This study aimed to assess the impact of IO on HSCT in terms of overall survival (OS), in addition to assessing its relationship with red blood cell transfusion support.

II. MATERIALS AND METHODS

Patients who underwent allogeneic HSCT from an HLA-identical related, unrelated, and haploidentical donor between 1996 and 2018 in the two institutions, with neoplastic and benign diseases, and who visited the post-transplant outpatient clinic from 2015 to 2019 with no evidence of disease relapse or infectious process were included in the study; of the 426 post-allogeneic transplant patients currently being cared, 199 of them who underwent routine follow-up, were enrolled in this study. These outpatient recipients were aged 18–65 years at the time of transplantation. No restrictions were applied in the conditioning regimen and indications for transplant.

This retrospective historical cohort study had an individualized, observational, and longitudinal epidemiological investigation design. It aimed to establish the relationship between red blood cell transfusions, patient's age, and hematologic disease and its implications on excess Fe after HSCT.

This study was approved by the Research Ethics Committees of Hospital São Paulo and Casa de Saúde Santa Marcelina. All study participants signed an informed consent form in accordance with the Declaration of Helsinki.

The following data were collected from the patients' medical records: time of transplantation, procedure-related complications, underlying disease, previous history of the disease, chemotherapy treatment, and transfusion history. At different times of the transplant, the patients

were invited to visit the outpatient clinics between 2015 and 2019 for an initial diagnosis of IO or follow-up of a previously established diagnosis. Clinical evaluation and serial laboratory tests such as serum Fe, ferritin, transferrin, and TSI were performed before HSCT and 100 days, 1 year, 3 years, 5 years, and >5 years after HSCT. The ferritin level was measured based on the data provided in the medical records and obtained during routine outpatient visits in patients not hospitalized and not presenting signs of infection or relapse at the time of examination.

The medical records were stored in paper-based documents, microfilms, or electronic systems. The data analyzed were available in the Blood Bank specific system. All clinical and laboratory parameters corresponding to the proposed variables were listed in Excel spreadsheets in the Office XP software.

Descriptive statistics were performed using Excel spreadsheets in the Office XP software along with the inferential analysis performed in the SPSS®. The categorical variables were expressed as absolute and relative frequencies. The distribution of numerical variables, especially the mean and maximum ferritin levels, was evaluated using central tendency measures. The numerical outcome variables were presented in a boxplot for the total sample or divided into categories of interest. Bivariate analyses were carried out as a joint assessment of the numerical and categorical variables using the boxplot. The distribution of the TSI numerical variable in the total sample and the categorical variable was visualized using a boxplot.

Numerical or continuous variables were expressed as central tendency measures of variability, and adherence to normality was evaluated using the Kolmogorov-Smirnov test. Numerical variables were compared in the same individual before HSCT and 100 days after HSCT. A parametric t-test was used to compare the difference between paired samples if the variable had normal distribution at both moments; otherwise, a Wilcoxon test was used, a non-parametric equivalent. The significance level was set at 0.05 for all tests. The OS curves for categories of the same variable were compared using the Kaplan-Meier test. The survival curves were compared using the log-rank test.

III. RESULTS

The study evaluated 199 patients, of whom 125 (62.8%) were from Casa de Saúde Santa Marcelina and 74 (37.2%) were from UNIFESP; among the total participants, 113 (56.8%) were men (M), while 86 (43.2%) were women (W), with a median age at the time of transplantation of 37 years. The population from the two institutions showed comparable demographic profile. The laboratory data equivalence was also evaluated, demonstrating similar maximum ferritin distribution in the two institutions (**Graph 1**). As for the time to elapsed from HSCT to inclusion in the study, 51.2% of the sample underwent HSCT 1 to 9 years ago (**Figure 1**). The sample included 159 (80%) patients who underwent identical-related allogeneic, 22 (11%) who underwent identical unrelated allogeneic, and 18 (9%) who underwent haploidentical transplants (**Table1).**

Patients with diseases that are indicated for transplant were grouped by etiological similarity and divided into large groups: benign anemia group (aplastic anemia and Fanconi anemia), acute leukemia group, Lymphoproliferative disease, chronic leukemia group, and myelo-dysplastic syndrome group. The sample was also categorized according to disease status at the time of transplant. The data showed a great proportion of patients with acute leukemias, and pre-transplant positive minimal residual disease (MRD+) was observed in 81 (40.7%) patients with this condition. A small part of the sample had lymphoproliferative diseases; however, the proportion of patients in partial remission is higher (**Table 2)**.

Post-HSCT was divided into the pre-transplant period, measured from the initiation of chemotherapy treatment and disease-specific clinical support until stem cell infusion, which included HSCT conditioning; immediate post-HSCT period, measured from the first 100 days after HSCT (starting from the time that the stem cells were infused), including the period of

immune recovery in which neutrophilic engraftment occurs within 30 days; intermediate post-HSCT period, measured from the first 30–100 days after HSCT; and late post-HSCT period, measured from the first 101 days to 1 year after HSCT, with CD19+ B lymphocyte recovery. A follow-up period of 3 to >5 years after the procedure was called prolonged post-HSCT.[8]

IV. FERRITIN ANALYSIS

The distribution of ferritin level was analyzed in the complete sample before transplantation and 100 days, 1 year, 3 years, 5 years, and more than 5 years after HSCT. The highest mean ferritin value was observed within 100 days after HSCT, with progressively decreased ferritin value 1 year after HSCT. The ferritin level was near normal 5 years after HSCT. (**Table 3**).

Individualized sample analysis showed that the highest mean ferritin levels in absolute numbers was reached within 100 days after HSCT in 146 (73.4%) patients, followed by a second peak in the ferritin levels in 44 (22.3%) patients 1 year after HSCT, with significantly decreased ferritin levels obtained in subsequent measurements.

The ferritin medians of 28 patients with complete Fe metabolism data available in all predetermined periods were evaluated; the highest median value was observed within 100 days after HSCT, it progressively decreased 1 year after HSCT, and was below 1,000 within 3, 5, and >5 years after HSCT (**Table 4**).

4.1 Ferritin analysis associated with red blood cell transfusion

More aggressive diseases such as acute leukemia require more intensive chemotherapy with greater myelotoxic potential and a greater number of transfusions. Two other categories, benign types of anemia (Fanconi Anemia and severe aplastic anemia) and myelodysplastic syndrome, require more blood transfusions, raking second and third in terms of the number of transfusions needed, respectively. On the contrary, lymphoproliferative diseases and chronic leukemias, which require less blood transfusion, rank fourth and fifth **(Graph 2)**.

Patients in the quartile with the highest number of transfusions (>20) have a higher pre-transplantation ferritin level; meanwhile, the ferritin levels progressively decrease in patients in the quartile with 20 to 10 transfusions and those in the quartile with less than 10 transfusions **(Graph 2).** Patients in the quartile with 20 transfusions have a higher post-transplant maximum ferritin value; that is, they reach the median ferritin values greater than 2,000 after HSCT. The mean maximum ferritin value subsequently decreased as the number of transfusions in each quartile decreased, with median ferritin levels of 1,500 in the quartile with 20 and 10 red blood cell transfusions and 1,100 in the quartile with less than 10 transfusions **(Graphs 3 and 4).**

4.2 Analysis of the impact of IO

Sample components showed high levels of post-transplant transferrin saturation, especially within 100 days after the transplant, with a median TSI of 43% **(Graph 5)**.

The sample presented higher TSI 100 days post-transplant, with a mean TSI of 46.93%. This finding correlates with the higher peak ferritin concentration in the same post-transplant period **(Table 5).**

OS was also impacted by the number of red blood cell transfusions; the group with the lowest number of transfusions (<10) achieved greater survival. Patients who underwent more than 20 transfusions had lower survival rates **(Graph 6).**

Ferritin-related survival was tested, with a ferritin level of >1,000 impacting survival; the OS decreased within 1 year after transplant, which was maintained for up to 5 years. The ferritin level of <1,000 slightly decreased after 1 and 3 years and remained stable after these periods, with greater survival compared with a ferritin curve of >1,000 (**Graph 7).**

As for OS-related transferrin saturation, greater survival was observed in patients with lower IO levels (TSI < 50%) even before HSCT. The OS was slightly affected within 100 days after the transplant based on the TSI. However, this impact

on survival was much greater when the same parameter was measured 1 year after HSCT (**Graph 8**). This finding shows that TSI is influenced by the transplant, reflecting what was observed with the ferritin level, a parameter peaking at 100 days and 1 year after HSCT. Serum Fe was another marker tested at all study time points and did not impact the survival when evaluated alone; however, it is necessary to calculate the TSI (serum Fe: transferrin × 0.71 = TSI × 100), thus indirectly impacting OS.

OS was impacted by the patients' age and was significant in patients aged below 25 years; the older the recipient, the greater the progressive survival decrease (**Graph 9**).

V. DISCUSSION

The study included 199 patients, of which 125 (62.8%) underwent HSCT at Casa de Saúde Santa Marcelina and 74 (37.2%) at UNIFESP. The population of the two institutions was restricted to the Public Health System (SUS) population and had similar characteristics such as age, sex, and socioeconomic status. The laboratory data collected at both institutions are comparable, with the median maximum ferritin level being similar in both institutions (**Graph 1**). Thus, it was possible to compare the data and treat the participants from both institutions as equivalent.

Yuan et al. evaluated the transfusion support of 1,792 transplant recipients; among them, 1,582 (88.3%) received red blood cell transfusions in the first 30 days after the procedure, with a progressively reduced transfusion need after this period and a consequent interruption in the transfusion support on an average of 60 days post-transplant. The mean number of red blood cell transfusions required within 30 days after HSCT was three units, with no record after 60 days.[9] The results of our study were similar, as none of the participants required red blood cell transfusion within 45 days after HSCT, with increased pre-transplant ferritin levels in patients with more than 20 red blood cell transfusions (**Graph 2**). Therefore, exogenous Fe from transfusions is one of the factors that can contribute to the occurrence of IO in the immediate post-HSCT period.

After complete immune reconstitution, transfusion independence was achieved after reestablishment of erythropoiesis.[10,11] However, within 100 days after HSCT, the ferritin level and TSI values increased, as demonstrated in **Tables 3, 4, and 5,** regardless of the interruption in transfusions. Therefore, high ferritin levels and IO cannot be attributed only to transfusion dependence, highlighting that the ferritin level remains high for up to 5 years, even if hemotherapy support is not required.

IO causes damage as it increases the level of non-transferrin bound Fe (NTBI), which causes oxidative stress, thus increasing the risk of transplant-related toxicity. Excess Fe increases the incidence of early HSCT complications such as acute graft-versus-host disease (GVHD), sinusoidal obstruction syndrome, and infections.

IO leads to a higher incidence of late complications such as chronic GVHD, liver cirrhosis, and cardiomyopathy.[12,13] These complications are directly related to the occurrence of toxicity produced by the use of conditioning regimen and immune-mediated reactions caused by graft-host interaction.

Therefore, it is important to determine the recipient's transplant stage and period of immune reconstitution to examine the dynamics of Fe metabolism at a certain stage. To demonstrate this relationship, data on serum Fe, ferritin, and transferrin levels were collected, and the TSI was calculated before transplant and 100 days, 1 year, 3 years, and 5 years after HSCT.

The discussion on which plasma marker is ideal to estimate IO in the transplanted body is always present and controversial. Ferritin is a widely available and easily evaluated marker; however, as it is an acute phase reactant and a marker of inflammation, ferritin is the most sensitive but not very specific marker for excess Fe. However, ferritin is considered a good screening tool, and a clinically significant IO (intracellular fluid (ICF) >7,000 g/g) is uncommon in patients with a ferritin level of <1,000 ng/ml. A previous meta-analysis found that a ferritin level of >1,000

ng/ml is a negative prognostic marker for non-relapse-related mortality (risk ratio = 1.7, p = 0.036).[14] For this reason, pre-transplant ferritin level, which demonstrates IO caused by transfusions; mean post-transplant ferritin level, which would be the mean ferritin level from stem cell infusion until late post-transplant; and maximum post-transplant ferritin level, which represents the maximum ferritin value achieved post-transplant, were used as markers.

A prospective analysis conducted by the Kanto Study Group for Cell Therapy divided 190 patients undergoing allogeneic HSCT for acute myeloid leukemia (AML) and MDS into two groups: those with ferritin level of >1,000 and those with a ferritin level of <1,000. Results showed that increased ferritin level decreased the patients' OS when ferritin level >1,000 at 1 year after transplant was compared with ferritin level <1,000 (63% versus 75%, p = 0,017).[15]

This study demonstrated that a mean ferritin level of >1,000 post-HSCT impacted the patient's OS (79% versus 91%; p<0,05) (**Graph 7).** The analysis used here was retrospective in nature and included patients at different transplant timepoints, up to 21 years post-HSCT, thus allowing a long-term analysis of the deleterious effects of IO, unlike Tanaka et al. who only analyzed the IO effects 1 year after HSCT. In addition, the author evaluated all onco-hematologic diseases without proper distinction, while the previous study only evaluated patients with AML and MDS. Another study analyzed the factor (patient's age) that influenced the OS. Patients aged less than 25 years showed higher OS, with older patients presenting a progressively decreased survival (**Graph 9**).

Meyer et al. investigated 290 patients undergoing myeloablative HSCT between 2000 and 2009. They reported a peak in the ferritin level within the first 3 months after HSCT, with the levels gradually returning to normal 5 years after HSCT, which corroborated with our results. According to that study, high ferritin levels are not associated with pre-HSCT transfusion dependence or GVHD. In all analyzed periods, a ferritin level of >1,380 decreased the post-transplant survival (0–6 months, p < 0.001; 6–12 months, p < 0.001; 1–2 years, p = 0.002; 2–5 years, p = 0.002).[10]

In terms of transfusion dependence, a significant difference was found in post-transplant mean maximum ferritin level for each disease. The mean maximum ferritin level was higher in diseases requiring greater transfusion support such as benign anemia, acute leukemia, and MDS.

Meanwhile, diseases mostly requiring outpatient follow-up, such as chronic leukemias and lymphoproliferative diseases, only ranked fourth and fifth in terms of transfusion demand (**Graph 4).** Patients in the quartile with >20 transfusions have a higher post-transplant maximum ferritin value, reaching a median ferritin value of greater than 2,000 in post-HSCT periods. The mean maximum ferritin value subsequently decreased with the reduction in the respective transfusion quartiles, with a median ferritin level of 1,500 in the quartile with 20 and 10 red blood cell transfusions, and a median maximum ferritin level of 1,100 in the quartile with less than 10 transfusions (**Graph 3).** Therefore, these results disagree with that of Meyer et al., as they showed that transfusion is an additional risk factor for post-transplant IO; however, as previously mentioned, the ferritin level remained high for up to 5 years regardless of the interruption in the administration of blood transfusions.

TSI was analyzed before HSCT and 100 days and 1 year after HSCT to assess whether these data reflect IO and follow the mean ferritin data. Then, we verified whether the transferrin saturation values in the sample were high, which resulted in an TSI of 46.93% within 100 days post-transplant and remained high 1-year post-HSCT, in 44% of the patients. This finding validates and corroborates the ferritin data, with the highest mean ferritin concentration in the same post-transplant period (**Table 5**) and excludes the bias of a possible underlying inflammation based on the ferritin values.

As for the prognostic impact of IO on HSCT, Armand et al. reviewed 590 patients undergoing myeloablative HSCT at the Dana-Faber Cancer Institute between 1997 and 2005. When patients with ferritin levels above and below 1,000

pre-HSCT were compared, the 5-year OS rates were 54% and 27%, respectively, while those of patients with single lineage dysplasia (SLD) were 43% and 27%, with decreased OS in the IO group due to non-disease-related mortality. Bazuave et al. corroborated these data in their analysis to some extent; of the 230 post-allogeneic myeloablative HSCT patients, those with a TSI of >69% had a 5-year OS of 5%, while those without IO had a 5-year OS of 52%.[11,14,16] These data corroborate the findings of our study, in which patients with a TSI of >50% (**Graph 8**) have a lower OS, especially when evaluated after 1 year (80%: TSI > 50% versus 92%: TSI < 50%, p < 0.05).

The results of this study demonstrated that the type of disease and dependence on red blood cell transfusion resulted in the reduction of patient's survival after HSCT. As illustrated in **Graphs 3 and 6**, the greater the number of red blood cell transfusion (>20 units), the lower the patient's survival. However, transfusion is no longer required in the late post-transplant period (>30 days and <100 days post-HSCT); therefore, the direct influence of transfusion cannot be considered the only factor responsible for this effect, with high pre-HSCT ferritin level being considered another predisposing factor for higher ferritin levels post-HSCT. Therefore, both the mean and maximal ferritin values are valid and should be used as indirect markers of post-transplant IO. This finding indicates that the pre-transplant ferritin levels should be analyzed and measured, and high levels should be controlled early whenever possible. This finding corroborates the results of the studies described above, thus reaffirming that high mean ferritin levels are not a simple consequence of pre-transplant transfusions or of the inflammation caused by use of conditioning regimens in the immediate transplant period.

VI. CONCLUSION

The data presented in this study corroborate the importance of assessing IO in HSCT survivors.

However, few studies estimate the clinical significance of IO post-HSCT using diagnostic parameters directly and indirectly quantifying IO. A few studies consistently correlate IO to inflammatory markers and plasma Fe levels.

Clinicians caring for HSCT patients in their daily practice need established and validated screening and therapeutic strategies to guide IO management post-HSCT. This series showed that IO is common in HSCT patients, with excessive pre-transplant transfusion being an additional risk factor. IO can occur up to 5 years after HSCT.

Hence, further studies are necessary to identify the causes of IO persistence in HSCT.

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Table 1: Sample characterization

			N	%
Group	Santa Marcelina		125	62.8
	Unifesp		74	37.2
Sex	Men		113	56.8
	Women		86	43.2
AGE of BMT	Mean	37,26 years		
	Median	37 years		
	Standard deviation	12,08		
Disease	Anemias		26	13.1
	Lymphoproliferative		18	9.0
	Acute leucemias		94	47.2
	MDS (myelodysplastic syndrome)		17	8.5
	Chronic leucemias		44	22.1
Pre-HSCT status	Active/refractory disease		70	35.2
	Disease in complete remission		111	55.8
	Disease in partial remission		18	9.0
Transplant Types	Related allogeneic HSCT		159	80
	Identical unrelated allogeneic HSCT		22	11
	Haploidentical allogeneic HSCT		18	9.0
Conditioning Types	Conditioning myeloablative BU / CY / VP / TBI		131	66.8
	Non-myeloablative conditioning FLU / TBI / FLUCYTBI /CYpost		49	23.6
	Reduced intensity conditioning CY / MEL / FLU		19	9.5

*BU: busulfan, CY: cyclophosphamide, VP: etoposide; TBI: total body irradiation, FLU: fludarabine, MEL: melphalan

Table 2: Disease profile and respective status

Disease	Sample N	Disease status
Benign types of anemia Aplastic anemia Fanconi anemia	 25(12,5%) 1(0,5%)	 24 activity and 1 partial response 1 activity
Lymphoproliferative diseases		
Hodgkin's lymphoma	2 (1%)	2 partial remission
Non-Hodgkin's lymphoma	8 (4%)	7 partial remission 1 activity
Multiple myeloma	8 (4%)	8 partial remission (post autologous 8
Acute leukemias		
Acute lymphoblastic leukemia	32 (16%)	1 activity/remission: 29 MRD+/2MRD-
Acute lymphoblastic leukemia	56 (28.1%)	5 activity/ Remission: 46 MRD+/ 3 MRD-
Ambiguous lineage leukemia	7 (3.5%)	1 activity/ remission 6 MRD+
Dendritic cell leukemia	1 (0.5%)	
Chronic Leukemias		
Chronic myeloid leukemia	38 (19.1%)	26 Activity or refractory/ 12
Chronic lymphocytic leukemia	6 (3.0%)	Partial response 4 activity/ 2partial response
Myelodysplastic syndrome		
RAEB (refractory anemia with excess blasts) 1	1 (0.5%)	1 activity
RAEB 2	13 (6.5%)	13 activity
CMML (chronic myelomonocytic leukemia)	1 (0.5%)	1 activity

Table 3: Ferritin in every patient sample by period

	N	Mean	Median	Standard Deviation	Minimum	maximum	Kolmogorov-Smirnov
Ferritin pre	133	1137.46	780	1139.351	14	7371	<0.001
Ferritin 100 days	139	1847.14	1509	1613.250	29	8000	<0.001
Ferritin 1 year	124	1526.54	960	1506.501	23	8476	<0.001
Ferritin 3 years	95	1006.54	613	949.583	24	5768	<0.001
Ferritin 5 years	91	574.64	377	499.959	17	2350	<0.001
Ferritin >5 years	97	389.79	280	323.594	15	1418	<0.001

Ferritin levels after transplant and 100 days, 1 year, 3 years, 5 years, and >5 years after transplant of all patients at each time point

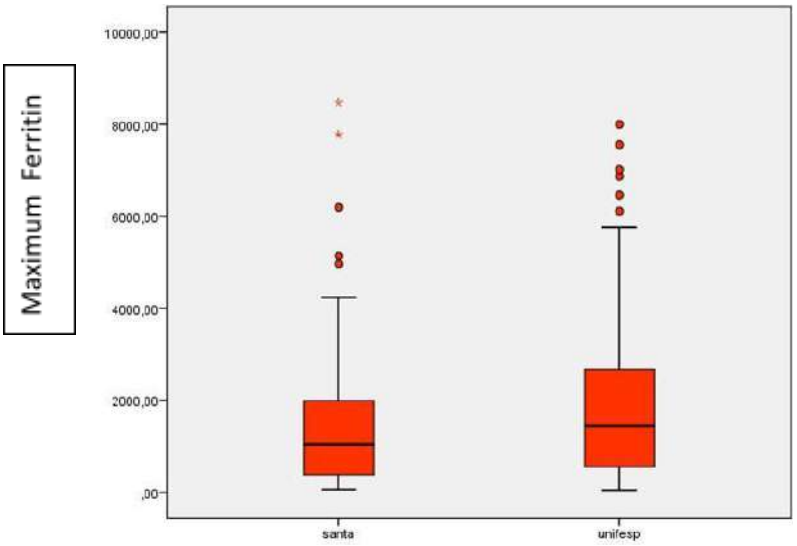
Table 4: Ferritin levels in patients with complete data in the six periods

	N	Mean	Median	Standard Deviation	Minimum	maximum	Kolmogorov-Smirnov
Ferritin pre	28	1107.70	518.00	1546.441	14	7371	<0.001
Ferritin 100 days	28	1675.16	1348.90	1532.039	29	7558	0.002
Ferritin 1 year	28	1195.00	804.50	1122.756	92	4788	<0.001
Ferritin 3 years	28	994.94	529.00	4894.716	11	3099	<0.001
Ferritin 5 years	28	560.80	413.65	451.099	37	1764	0.060
Ferritin >5 years	28	484.58	313.50	377.192	15	1418	0.001

Median ferritin level before transplant and 100 days, 1 year, 3 years, 5 years, and >5 years after transplant in patients with complete ferritin data on all transplant stages

Table 5: Distribution of transferrin saturation index before and 100 days after BMT

TSI in the period	mean	median	Standard deviation	Minimum	Maximum	CI 95% smaller	CI 95% Greater	Kolmogorov -Smirnov
TSI pre-HSCT	43.91	41.50	28.773	10	97	35.93	52.46	<0,001
TSI 100 days HSCT	46.93	46.93	22.116	10	102	40.3	53.50	<0.001
TSI greater than 1 year	40.04	30.50	21.135	12	105	33.7	46.32	<0.001



Graph 1: Maximum ferritin level reported in the institutions

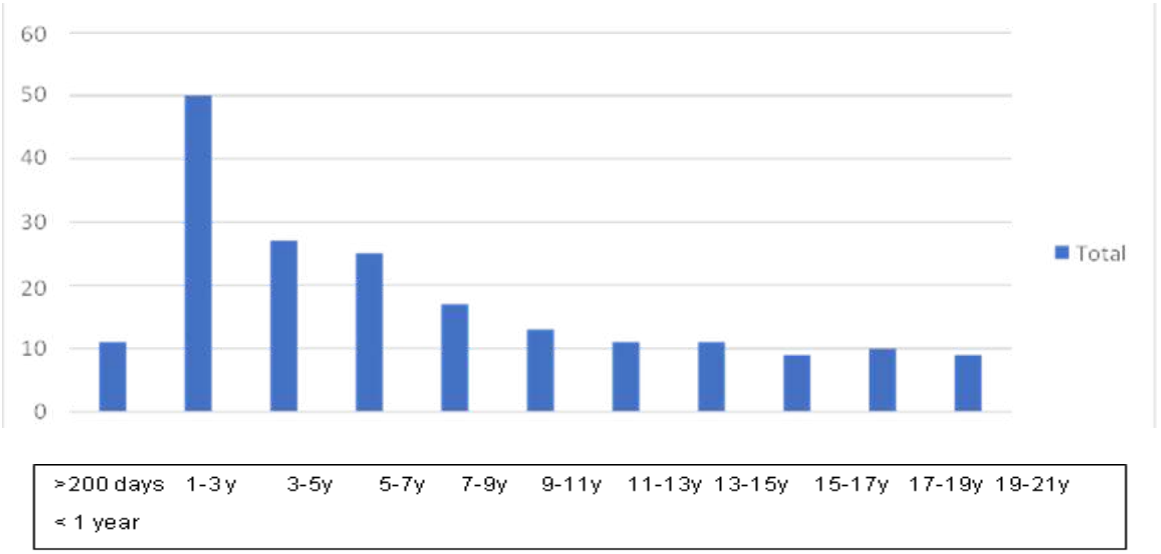
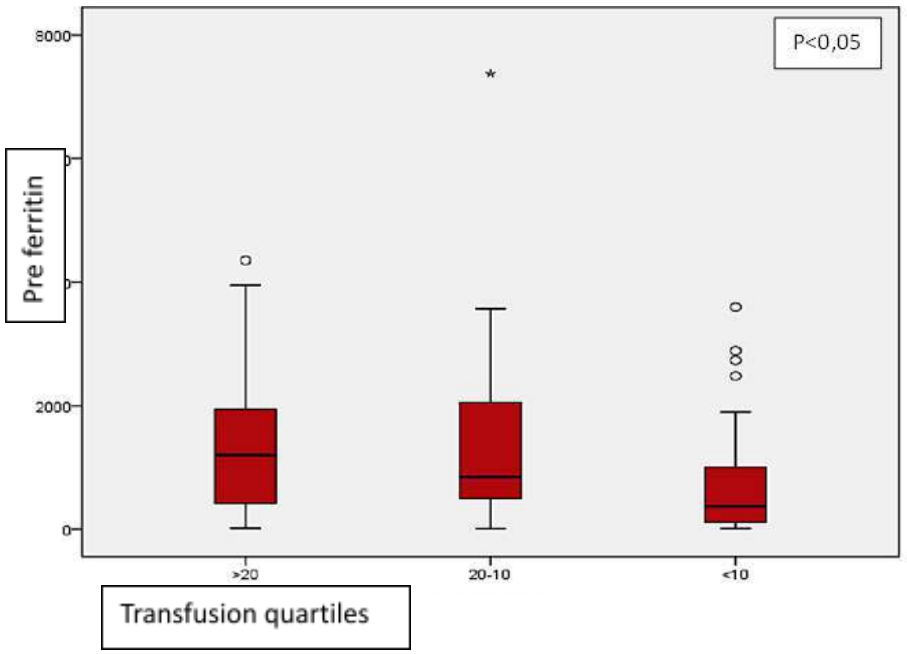
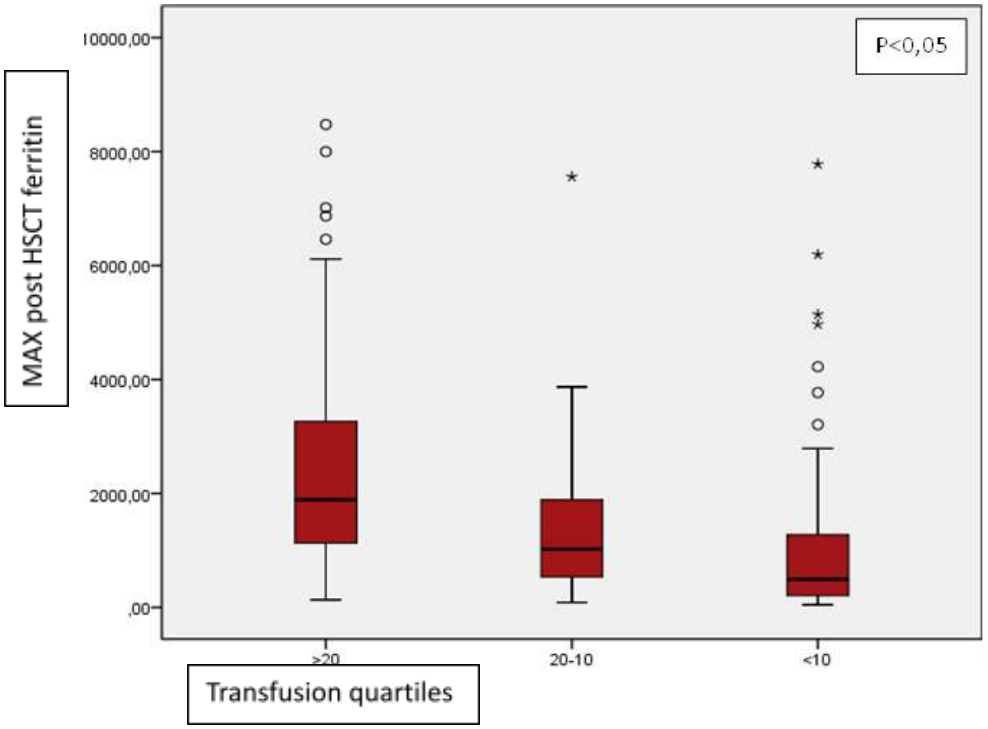


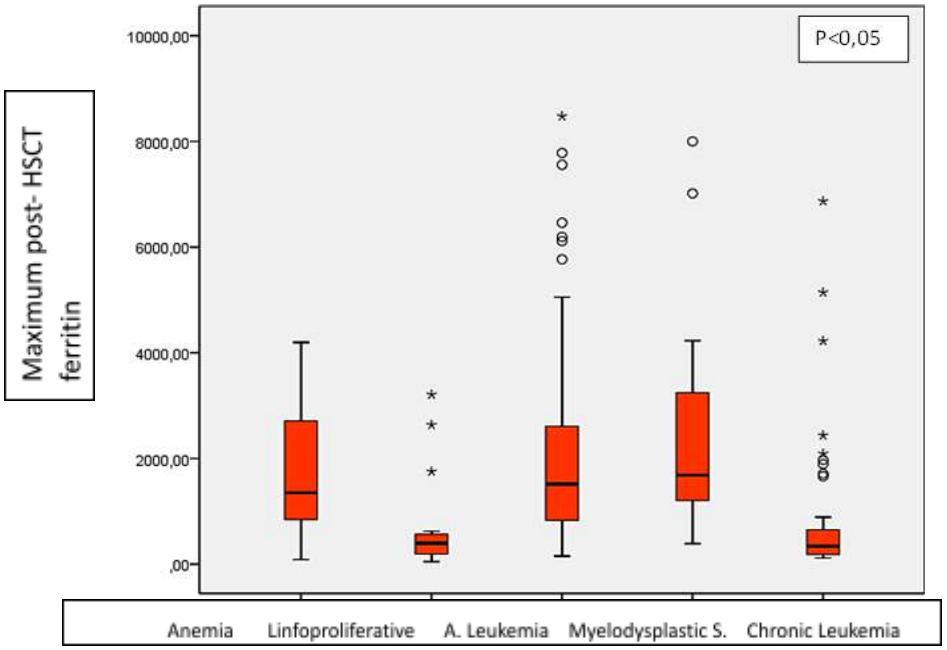
Figure 1: Number of patients by HSCT stage (in years) at the time of inclusion in the study



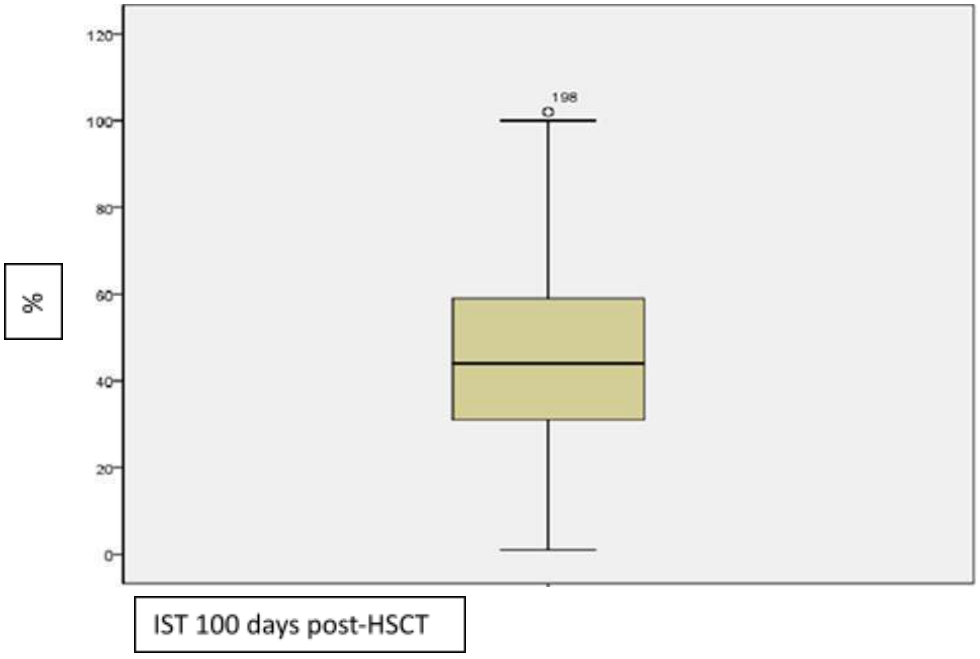
Graph 2: Pre-HSCT ferritin level. Quartiles by number of packed red blood cell transfusions (>20, 20–10, and <10)



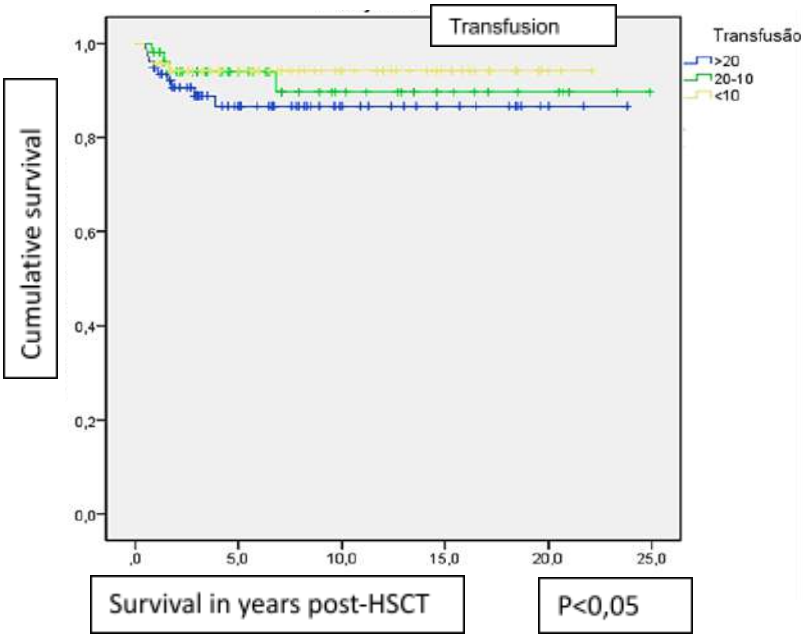
Graph 3: Maximum post-HSCT ferritin level × number of red blood cell transfusions. Quartiles by number of packed red blood cell transfusions (>20, 20–10, and <10)



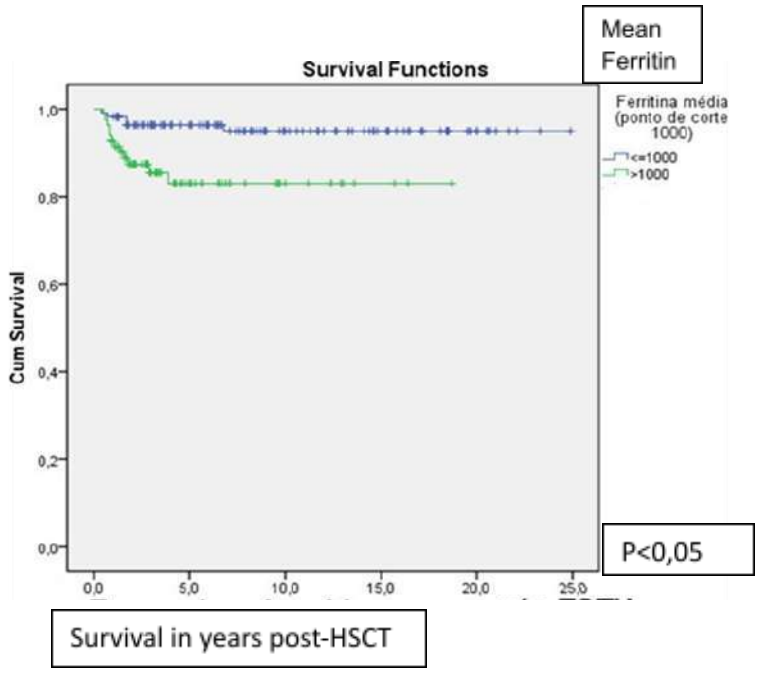
Graph 4: Maximum post-HCST ferritin level versus disease. Diseases: benign types of anemia (AF and AAS), lymphoproliferative disease, acute leukemia, myelodysplastic syndrome, and chronic leukemias



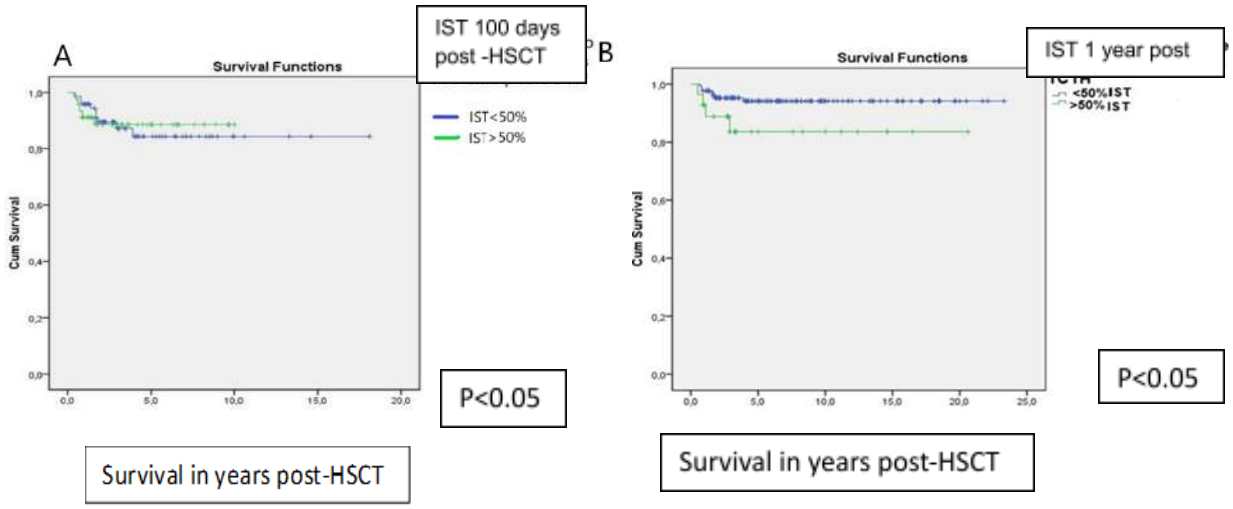
Graph 5: Transferrin saturation index 100 days post-HSCT



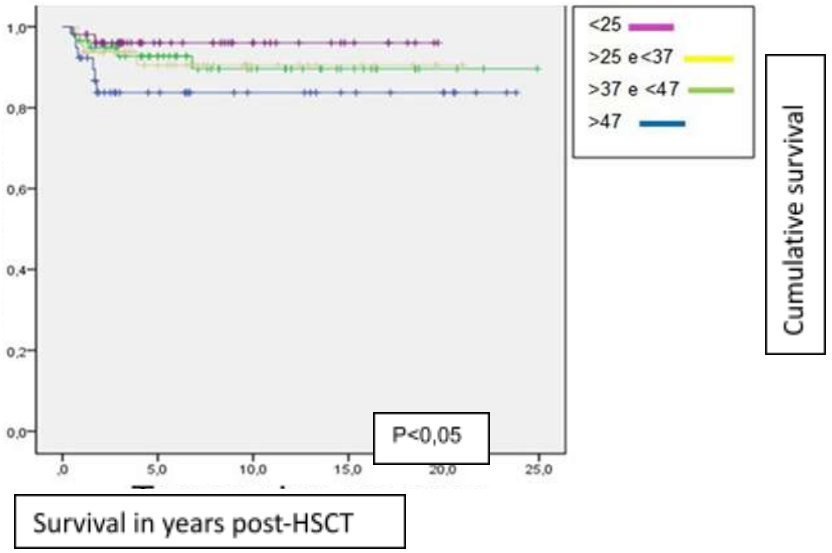
Graph 6: Survival outcomes according to the number of red blood cell transfusions. Number of transfusions: 0–10, 10–20, and >20



Graph 7: Survival versus mean ferritin level. Survival in years related to ferritin >1,000 and <1,000



Graph 8: A. TSI within 100 days after HSCT versus survival. B, TSI 1 year after HSCT versus survival



Graph 9: Survival time in years versus age quartiles at the time of transplant

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Individual-Related Factors Influencing the Striking Gender Inequality in the Nursing Profession, a Cross Sectional Study among Nurses and Student Nurses from Selected Hospitals and Nurses Training Institutions in the Northern Cities of Uganda

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ABSTRACT

Introduction: The study discovered that the striking level of gender inequality in the nursing profession, is partially influenced by some individual related factors like gender where male are only 26.4%. This striking numerical gender inequality, has positioned the few male especially those at a care giving role, at a more risk of psychological abuses from the patients/attendant, fellow nurses and other health professionals. Patients/attendants wrongly calls them doctors while some of their female counterpart and other health professionals says they are academic failures who have failed to be doctors. This is psychological abuse and gender discrimination in the female dominated profession. For that reason, the study has exposed that some of the youthful male in the profession are suffering the effect of psychological abuse evidenced by them avoiding the nurses' uniform and putting on scrub clothes in order to confuse and meet public expectation of them being doctors. In addition, the 3.7% Muslims is an outstanding religious affiliation disparity in the profession.

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ABSTRACT

Introduction: The study discovered that the striking level of gender inequality in the nursing profession, is partially influenced by some individual related factors like gender where male are only 26.4%. This striking numerical gender inequality, has positioned the few male especially those at a care giving role, at a more risk of psychological abuses from the patients/ attendant, fellow nurses and other health professionals. Patients/attendants wrongly calls them doctors while some of their female counterpart and other health professionals says they are academic failures who have failed to be doctors. This is psychological abuse and gender discrimination in the female dominated profession. For that reason, the study has exposed that some of the youthful male in the profession are suffering the effect of psychological abuse evidenced by them avoiding the nurses' uniform and putting on scrub clothes in order to confuse and meet public expectation of them being doctors. In addition, the 3.7% Muslims is an outstanding religious affiliation disparity in the profession.

The 43.3% of the gender discriminated nursing professionals were told that they are academic failures but this study has dismissed that claim. It has confirmed that all the nurses/student nurses has attained the minimum set standards by Uganda Ministry of Education and Sports to professionally train with the main aim of saving life though graduate nurses are still few at only 6%.

The study has unveiled that 9.1% of the nurses have joined the profession because of mistreatment of patients/attendants by some nurses. Much as most of the nurses/student nurses were motivated to join the profession to help the sick, some were for employment opportunity and others because of the nurses dressing code. It has been found that there is a gradual generational mind set change about the profession being a female profession to a gender neutral profession. 78.5% of the respondents proof it by saying they would recommend both gender to join the profession since they are all capable of serving and saving life. But, there is still a mixed feeling about the male in the profession, some nurses and student nurses says they are academic failures, some are using nursing as a stepping stone to their next medical profession while some respondents said that some of the male in nursing are very good, very knowledgeable, hardworking and caring than the female nurses. All these finding justifies individual related factors influencing gender inequality in the nursing profession. The main study objectives was to established the factors influencing gender inequality in the nursing profession among nurses and student nurses from the selected hospital and nurses training institution in the Northern Cities of Uganda. The specific objective was to determine individual related factors influencing Gender inequality in the Nursing Profession among the respondents from the study sites.

Methodology: the study used a cross-sectional study design to obtained quantitative data from

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the respondents in Gulu, Lira and Arua Cities. Trained research assistants used a pretested structured English questionnaire to obtain the raw data which were single entered and analyzed using statistical software version Frequency tables and graphs were used to describe the study variables. Univaraite and bivariate analysis methods were used to identify factors associated with gender inequality. Variables with P-value of <0.05 with 95% confidence interval were used to declare statistical significance.

Results: 383 participants were interviewed generating 95.6% responses. 4.4% non-responses were due to various reasons which doesn't affect result. Most of the respondent who had experienced gender discrimination, 34.2% were from patients/attendants and 26.3% were from fellow nurses/students. 35.5% of the respondents think some of the male nurses are using nursing as a stepping stone to being doctors. Gender (x^2- 10.294, p-value 0.001), level of education (x^2- 6.293, p-value 0.043), religious affiliation (x^2- 8.296, p-value 0.004), level of program of training (x^2- 10.453, p –value 0.015), experience of discrimination (x^2- 4.360, p- value 0.0037) and gender to recommend for nursing profession (x^2 - 6.024, p-value 0.049) were some of the individual related factors which were significantly associated to gender inequality in the nursing profession.

Conclusion: gender inequality affecting nursing profession is greatly influenced by individual related factors though other factors may also be contributing. Other than gender itself, there is striking numerical religious inequality with Muslim being the marginalised group.

Patients/attendants, other health professionals and nurses themselves are the perpetuator of gender discrimination in the profession. Some of the impact of the discrimination is revealed in most of the stigmatised youthful male at a care giving role. They are avoiding the nurses' professional uniform to confuse and meet the public expectation of them being doctors. Parents and other relatives do greatly influenced the decision of a child to be a nurse for job security. Unprofessional conduct of some nurses on patients/attendants is a negative motivating factor for some individual to join the profession. The gradual generational mind set change about nursing being a female profession to a gender neutral profession need to be accelerated.

Recommendation: Swift action is needed from International and Non-Governmental Organizations, Government Ministries, Nurses and Midwives councils, National Nurses and Midwives Organizations as well Religious leaders for a comprehensive and collaborative effort in mind set change of the public. More research; evidenced based policy change and development; effective implementation strategies and monitoring the implementation process in order to bridge the gaps of gender equality and save the nursing profession from the unfairness which at the end impact on the patient.

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I. BACKGROUND OF THE STUDY

Gender is economic, social and cultural attributes and opportunities which determines what is expected, allowed and valued in a woman or a man (jhpiego, 2020).Gender equality is a condition of equal rights, responsibilities and opportunities for all genders. Gender inequality is therefore a social process where men and women are treated differently by having special consideration for one gender. According to declaration of Philadelphia, all human beings irrespective of race, faith or sex; have the right to obtain material wellbeing and spiritual development in conditions of freedom and dignity, economic security and equal opportunity (Press, 2021). WHO in the 49th World Health Assembly, recognized the potential of Nurses to quality and effective Health services and suggested that nurses must be involved at all level of Health System. (Sharrif & Potggieter, 2012).

According to Sunday Summer, gender inequality in nursing profession is numerically distinct with female being predominant and their handling reflects the way women are treated in the society

(Summer, 2017). Media portrays them feminine stereotypes like low skilled handmaiden, sex objects, angels or battle axes and the male are gender stereotyped as gay or weak. (Summer, 2017).Nursing profession is the biggest and fastest growing employment sectors globally for women with about 234 million workers (WHO, 2019). According to the state of the world's Nursing report, Globally nurses are the largest group of health care worker contributing 28 million health work force based on data collected from 191 Countries (WHO, 2020).The report also indicated that 90% of nurses are female and the omission of data about entry salaries, investment in nursing education and gender wage gap is indicator of gender inequality in the profession.

Rosemary Morgan, assistant scientist at Johns Hopkins Bloomberg School of Public Health and School of Nursing said that nurses are discriminated at workplace on the basis of identity. With the Covide19 pandemic, gender inequality at work place has put female nurses at more risk than the male nurses with 73% of the health workers infected in the United State were the female nurses because of their employment position at a care giving roles.

In Africa, 76% of nurses are women and the global gender inequality in Nursing has allowed the profession to follow a stereotype where in low and middle income countries; Nursing is considered second choice for those that have fail to make it to their preferred profession while in developed countries the low rate of men in Nursing is an indicator of how nursing is viewed globally said Emily Katarikawe, Uganda country Director of Jhpiego (WHO, 2020). There is also a large pay gap between the men and female in Nursing Profession where men are at the higher paying leadership position while the female are at the lower paying roles as stated by Michelle McIsaac, an Economist at WHO (WHO, 2020).

In Uganda, most Nurses are female though men are joining the profession. According to the study done in Mbarara Regional Referral Hospital, male nurses are seen as misplaced, misunderstood as practitioners from other discipline and are mistreated by the colleagues of the profession or other health care workers (Susan, 2016).

In Northern Uganda, there is no evidence of any similar study conducted as well in Gulu, Lira and Arua Cities, yet gender inequality affects the profession at all level of service delivery.

The specific objectives of the study was to assess the individual related factors influencing gender inequality in the nursing profession.

II. METHODOLOGY

The study methodology is the same as in the previous article, "the striking level of gender inequality in the nursing profession, a cross sectional study of selected hospitals and nurses training institution in the northern cities of Uganda".

III. RESULTS

Individual related factors influencing gender inequality in the nursing profession.

Table 3: Univariate analysis of individual related factors influencing gender inequality in the nursing profession

Variables	Category	Frequency N	Percentage %
Institutions	Hospital Nurse training institution	182 170	51.7 48.3
Gender	Female Male	259 93	73.6 26.4
Age	18-24 years 25-34 years 35-44 years >44 years	187 109 29 27	53.1 31.0 8.2 7.7
Highest level of education attained?	Post graduate/Bachelor Tertiary Secondary	21 178 153	6.0 50.6 43.5
Preferred course after secondary level of education	Nursing Medicine (Doctors). Engineering Others	171 96 46 39	48.6 27.3 13.1 11.1
Religion affiliation	Christian Muslim	339 13	96.3 3.7
Marital status	Single married	216 136	61.4 38.6
Level of program	Post graduate in nursing Bachelor of nursing science Diploma in nursing Certificate in nursing	13 49 278 12	3.7 13.9 79.0 3.4
Person who decided for you to be a nurse	No one My parents My friends/relatives/My teachers	205 97 50	58.2 27.6 14.2
Motivation factors to join nursing profession	Helping the sick Employment opportunity. Dressing code. Mistreatment of patients/attendants by some nurses. Others	167 72 61 32 20	47.4 20.5 17.3 9.1 5.7
experienced any of form of discrimination because of your gender	Yes No	49 303	13.9 86
Thought of the men in the nursing profession	Are academic failures. Most of them are using nursing as a stepping stone that is why they don't like being a nurse but want to be doctors. Some are very good, very knowledgeable, hardworking and caring than the female nurses.	84 125 91	23.9 35.5 25.9

	Others	52	14.8
Recommending any gender to join the nursing profession	Yes No	312 40	88.6 11.4
Gender would recommend	Male Female Both male and female	9 58 245	2.9 18.6 78.5
Gender would recommend	Male Female Both male and female.	9 58 245	2.9 18.6 78.5
Reason for recommending the particular gender	Female are fit to be nurses and more Committed Male are not fit to be nurses, they should be doctors. A profession for both gender, all are capable of serving and saving life. Promotion of gender equality Others	47 104 115 40 6	13.4 29.5 32.7 11.4 1.7

According to table 1 above, 51.7% of the respondents were from hospital, 48.6% preferred nursing at their secondary level choice, and 79% had diploma in nursing, 58.2% decided for themselves about the course, 47.4% were motivated for the passion for helping the sick, 86.1 had not experienced any form of discrimination in the nursing profession, 35.5% of the respondents think male nurses are using nursing as a stepping stone that is why they don't like being a nurse but want to be doctors, 88.6% would recommend any gender for nursing professions, of those 78.5% would recommend both gender and 32.7% would do so because nursing is profession for both gender, all are capable of serving and saving life.

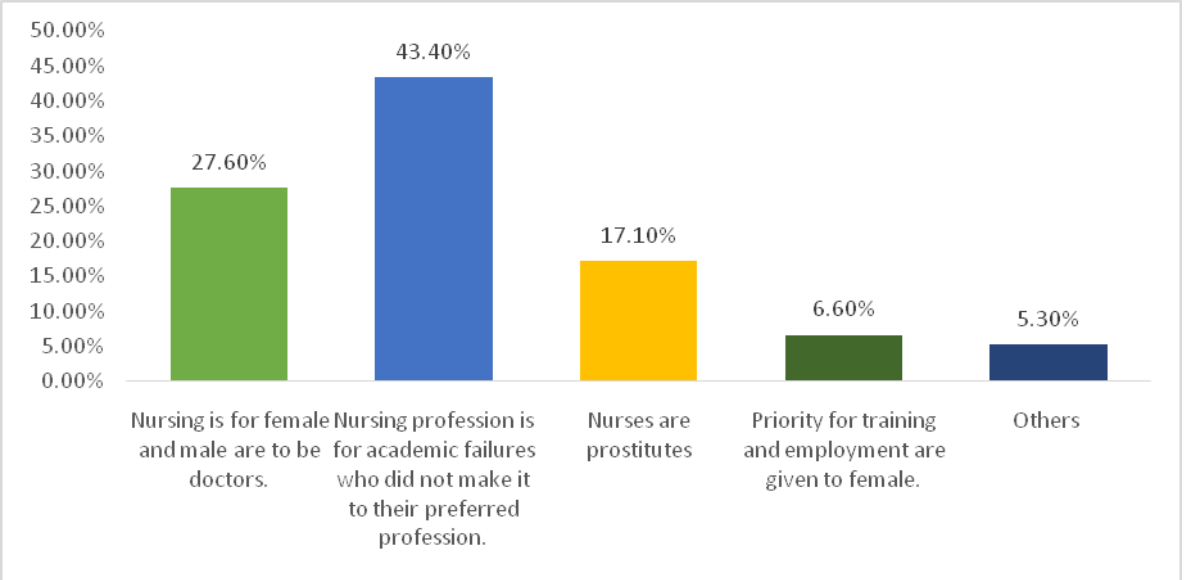

Figure 3: Showing the description of form of discrimination

On the discrimination, most of the respondents 43.4% were told nursing profession is for academic failures who did not make it to their preferred professions and more details are presented in figure 1 above

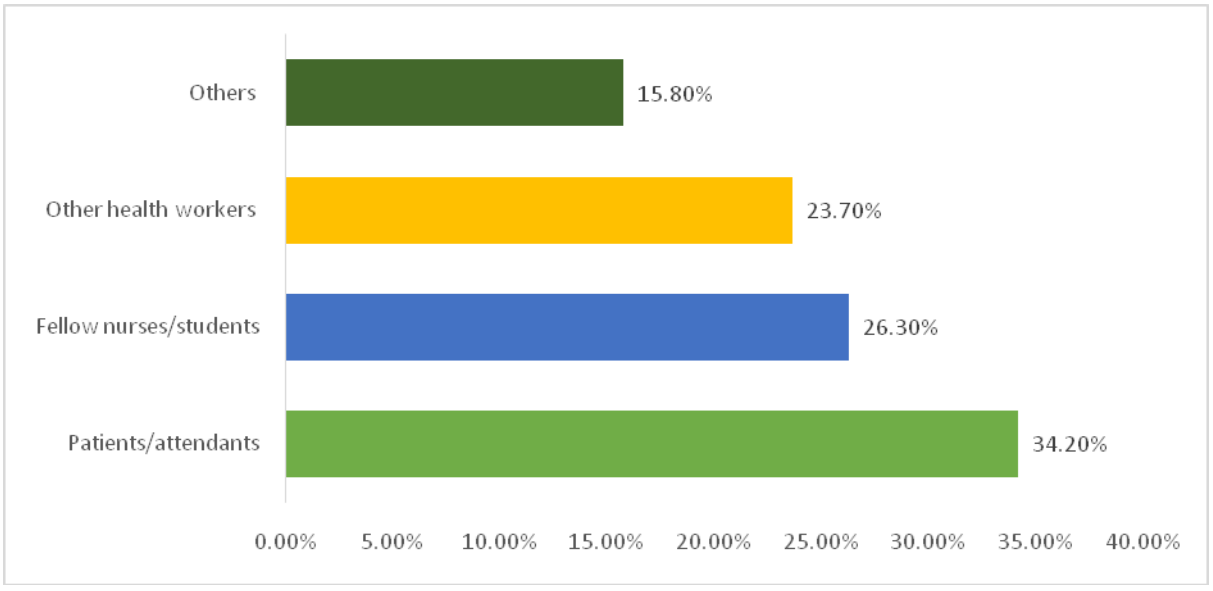

Figure 4: People who are perpetuator of the discrimination

Most of the respondent who had experienced discrimination, 34.2% were from patients/attendants, 26.3% were from fellow nurses/students.

Table 4: Bivariate analysis of individual related factors influencing gender inequality in the nursing profession

Variables	Category	Present (%)	Absent (%)	$_x2$	p- value
Institutions	Hospital Nurse training institution	44(57.9%) 32(42.1%)	138(50.0%) 138(50.0%)	1.487	0.223
Gender	Female Male	45(59.2%) 31(40.8%)	214(77.5%) 62(22.5)	10.294	0.001
Age	18-24 years 25-34 years 35-44 years >44 years	32(42.1%) 28(36.8%) 8(10.5%) 8(10.5%)	155(56.2%) 81(29.3%) 21(7.6%) 19(6.9%)	4.943	0.176
Highest level of education attained?	Post graduate/Bachelor Tertiary Secondary	7(9.2%) 45(59.2%) 24(31.6%)	14(5.1%) 133(48.2%) 129(46.7%)	6.293	0.043
Preferred course after secondary	Nursing Medicine (Doctors) Engineering Others	37(48.7%) 18(23.7%) 13(17.1%) 8(10.5)	134(48.6%) 78(28.3%) 33(12.0%) 31(11.2)	1.693	0.638
Tribes	Acholi/langi/Alur Lugbara/Madi/Kakwa Bantu Other	37(48.7%) 19(25.0%) 8(10.5%) 12(15.8%)	146(52.9%) 58(21.0%) 42(15.2%) 30(10.9%)	2.768	0.429
Religion affiliation	Christian Muslim	69(90.8%) 7(9.2%)	270(97.8%) 6(2.2%)	8.296	0.004
Marital status	Single Married	43 (56.6%) 33 (43.4%)	173 (62.7%) 103 (37.3%)	0.936	0.333
Level of program	Post graduate in nursing Bachelor of nursing science Diploma in nursing Certificate in nursing	4(5.3%) 15(19.7%) 51(67.1%) 6(7.9%)	9(3.3%) 34(12.3%) 227(82.2%) 6(2.2%)	10.453	0.015
Person who decided for you to be a nurse	No one My parents My friends/relatives/My teachers	44(57.9%) 19(25.0%) 13(17.1%)	161(58.3%) 78(28.3%) 37(13.4%)	0.806	0.668
Motivation factors to join nursing profession	Helping the sick Employment opportunity Dressing code Mistreatment of patients/attendants by some nurses Others	42(55.3%) 12(15.8%) 14(18.4%) 4(5.3%) 4(5.3%)	125(47.4%) 60(21.7%) 47(17.0%) 28(10.1%) 16(5.8)	3.939	0.414
Experienced of any form discrimination because of one gender	Yes No	5(6.5%) 71(93.4%)	44(14.9%) 232(84.1%)	4.360	0.037
Thought of the men in the nursing profession	Are academic failures Most of them are using nursing as a stepping stone that is why they don't like being a nurse but want to be doctors Some are very good, knowledgeable, hardworking and caring than the female nurses	17(22.4%) 25(32.9%) 21(27.6%)	67(24.3%) 100(36.2%) 70(25.4%)	0.752	0.861

	Others	13(17.1%)	39(15.1%)		
Recommending any gender to join the nursing Profession?	Yes No	69(90.8%) 7(9.2%)	243(88.0%) 33(12.0%)	0.446	0.504
Gender one would recommend	Male Female Both male and female.	5(7.2%) 12(17.4%) 52(75.4%)	4(1.6%) 46(18.9%) 193(79.4%)	6.024	0.049
Reason for recommending the particular gender	Female are fit to be nurses and more committed Male are not fit to be nurses, they should be doctors A profession for both gender, all are Capable of serving and saving life Promotion of gender equality Others	7(9.2%) 14(18.4%) 13(17.1%) 29(38.2%) 12(15.8%)	33(12.0%) 91(33.0%) 86(31.2%) 28(10.1%) 5(1.8%)	9.988	0.076

Most of the respondent who had experienced discrimination, 34.2% were from patients/attendants, 26.3% were from fellow nurses/student

Among the individual factors, Gender (x^2- 10.294, p-value 0.001), level of education (x^2- 6.293, p-value 0.043), religious affiliation (x^2- 8.296, p-value 0.004), level of program of training (x^2- 10.453, p –value 0.015), experience of discrimination (x^2- 4.360, p-value 0.0037) and gender to recommend for nursing profession (x^2 - 6.024, p-value 0.049) were significantly associated to gender inequality in the nursing profession.

IV. DISCUSSION

Individual related factors

The study found that gender; religious affiliation; level of education attained; level of educational training; experience of gender discrimination and gender to recommend for nursing courses were some of the individual related factors that are significantly associated with gender inequality in the nursing profession (NP).

In addition, it noted that there is only 26.4% male, possibly because the minimal increase in gender depiction over time in the NP, has not yet caused a numerical gender balance globally as reported by different researchers. Female nurses globally and Africa are at 90% and 76% respectively (WHO, 2020). From the study, we renowned that the stereotype that Nursing is a female Profession is still prevailing among the Ugandan nurses/student nurses and the community. This is in line with Twomey, (2011) who found that this stereotype has reduced the number of males interested in the profession. The few male nurses have had problems of professional acceptance just as Susan (2014) stated in her report. The general society, their families and even some of the female counterparts isolate them from the female nurses and profession work group which is not any different from some male nurses' experiences in this study. Though majority of the male in the profession are called doctors by patients/ attendants, implying that they are not expected to be nurses, even most of the fellow nurses says they are not fit to be nurses but should be doctors.

This is psychological abuse and stigmatization of the male in the profession. Due to that, it has been exposed that most of the youthful male in the NP are stigmatized evidenced by their unprofessional dressing code when on duty. This was observed in all most all the hospitals but more marked in the RRH where most male prefer scrub or a half scrub clothes to nurses' professional uniform especially at a care giving role to hide their nurses identity, perhaps to confuse and meet public expectation of them being doctors. One of SPNO lamented that the unprofessional dressing code of male nurses on duty are getting out of hands. Patients/ attendance confused them for Doctors as well giving most of the female nurses a negative impression about them that they are in the wrong profession. This behaviour has direct impact on the patients nursing care and health improvement due to the divided attitudes.

Furthermore, some male nurses have confirmed the allegation by some nurses that they use the profession as a stepping stone for other medical courses. This has built on Emily Katarikawe, Uganda Country Director of Jhpiego remark, that nursing is considered second choice when first choice fail (WHO, 2020). The study discovered that majority of nurses 58.2%, choose it at O' level (senior four). At A' level (senior six), most students undertaking science subjects have preferred to be doctors or engineers but get back to nursing at a certificate level if they fail to score the university minimum set points. From the study, 58.2% majority of nurses made their decision to join the profession. 47.4% had passion to help the sick though others were because of job security and nurses dressing code. But, the study has exposed that a minority of 9.1% were motivated because of the unprofessional conduct of mistreating patients/attendants by some nurses. Possibly, the nurses who are claimed to have mistreated patients/attendants, their choices of the profession were influenced by their parents, relatives and friends or their motivating factors for nursing was not serving and saving life. Also, one of the SPNO from a RRH stated that some of male where possibly forced by their parents to be nurses because of the surety of jobs after completion of training because some of their unprofessional behaviour when on duty. Not only that but also, the outstanding numerical religious affiliation inequality indicates that Muslims are only 3.7% in the nursing profession possibly because of the dos and don'ts in the Islamic religion that needs more research to detail it out.

To continue, the study uncovered that both male and female nurses are experiencing gender discrimination from all directions i.e. patients/ attendants, other health professional, fellow nurses/student nurses and even their family and friends though Summer (2017) noted only male nurses experiences of conflicting images. In our finding it was realized that both male and female in the profession experience conflicting images where some are appreciated for being loving, caring, hardworking, smart intellectually and easy to approach while others are rude, proud, arrogant, lazy, fulfilling personal interest, academic failures, misplaced and practitioners of other discipline. Just like the female counter part, some of the male had the passion of being nurses.

Naturally men are stronger emotionally than the female which is of an advantage to the patients.

Bradon *et al,* 2021 in their findings indicated that the few men in the profession use it as double edge sword for senior nursing position and higher salaries concurrently but the study has differed from them. Most of the managers reported no salary difference and promotions are based on academic qualification and experience for both gender. On observation, it was noted that there is gender imbalances even at higher nurses position where all most all the SPNO were female justifying Brody findings where it was stated that the imbalance gender proportion at jobs position has remained a key issues in health sectors (Brody, 2019) Bradon and team explained that men still experience gender stereotyping, prejudice and discrimination even at higher position.

Majority of the discriminated respondents were told that nursing profession is for academic failures who did not make it to their preferred professions but according to the students

nurses/nurses and the managers of all the study institutions, they have said that for one to be admitted for training as a certificate nurse, the lowest cadre in Uganda, you must have a Uganda certificate of education with good passes in Biology, mathematic, chemistry, English and physics.

The study unveiled that the nursing profession in Uganda still has very few graduate nurses may be most of them join NGO's after completion since the government had no salary scale hence no employments for them until of recent when it was sorted out. This finding therefore dismiss the claim by some people that nursing profession is for academic failures. Of the students interviewed, 79% were upgrading from certificate to a diploma level, showing the trend in which the profession is going.

In the current transitions in nursing profession, most of the respondents confirmed that they would recommend someone to join the profession. 88.6% said they would recommend any gender because they are fit to be nurses and more committed especially the female. Of those, 78.5% said they would recommend both gender to promote gender equality showing that the new generation in NP are realizing the importance of gender equality in the provision of nursing care and 32.7% would do so because nursing is profession for both gender and all are capable of serving and saving life. The outcomes of the study has confirmed Judie and Jayapal report of 2020 about the transformation ideology of nursing from female profession to gender neutral profession. Hence, supporting the achievement of SDG 4 (four) that aims at ensuring, inclusive and equitable quality education and promoting lifelong learning opportunity for all.

V. CONCLUSION

The individual related factors are greatly and collectively contributing to gender inequality in the nursing profession though other factors may be contributing.

VI. RECOMMENDATION

1. A comprehensive approach to effective and efficient individual mind-set change should be used. Governments; Nurses and Midwives Council (NMC); National Nurses and Midwives Organizations and religious leaders should developed and lead a standard programs for Public and professional campaign awareness about nursing as a gender neutral profession, abuses, victims of abuse and abuser and appropriate stress management to be decentralized and monitored by the NMC.
2. Health facilities should have an independent functional offices or contacts displayed for easy accessibility by complainants of abuse claims with an effective and efficient investigation and management team lead by a human right activist and monitored by the nurses and midwives council for a positive impact to the nurses, the profession and the patients.
3. More research is needed on gender inequality in the nursing profession and its effect on health service delivery in order to achieve equality across all domain.

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The list is endless but I apologize to those whose name were not mention but you are not forgotten. May God bless everyone and reward you abundantly.

List of abbreviations

WHO	World Health Organization
MOH	Ministry of Health.
NMC	Nurses and Midwives Council
PI	Principal Investigator
SPNO	Senior Principal Nursing Officer
RRH	Regional Referral Hospital
NTI	Nursing Training Institution
SNM	School of Nursing and Midwifery
EIGE	European Institute for Gender Equality
SDG	Sustainable Development Goal
MDG	Millennium Development Goal
REC	Research Ethics Committee
UNCST	Uganda National Council of science and Technology
CIU	Clarke International University
NP	Nursing Profession
O' level	Ordinary level of education
A' level	Advanced level of education
GI	Gender Inequality
SPSS	Statistical package for social scientist

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Conflict of interest

The study had no conflict of interest.

Biasness of the study

The study had no biasness.

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Longitudinally Extensive Transverse Myelitis in Measles: A Rare Case Report and Review of the Literature

Dr. Gajjar Jay Daxay, Dr. Madhur Sarthalia, Dr. Susheel Kumar Saini & Dr. Seema Kumari

ABSTRACT

We report a rare case of longitudinally extensive transverse myelitis (LETM), a rare but disabling condition defined as a lesion of the spinal cord that extends over four or more vertebrae on MRI, in association with measles. Measles related devastating neurological disorders include primary measles encephalitis, acute post measles encephalitis, subacute sclerosing panencephalitis (SSPE) and measles inclusion body encephalitis (MIBE). Due to rarity of disease and poor prognosis of LETM in patients, prompt diagnosis and treatment is of critical importance for a positive clinical outcome. We provide a comprehensive perspective of past and current literature in order to aid diagnosis and management of this rare phenomenon

Keywords: longitudinally extensive transverse myelitis, measles, rare.

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ABSTRACT

We report a rare case of longitudinally extensive transverse myelitis (LETM), a rare but disabling condition defined as a lesion of the spinal cord that extends over four or more vertebrae on MRI, in association with measles. Measles related devastating neurological disorders include primary measles encephalitis, acute post measles encephalitis, subacute sclerosing panencephalitis (SSPE) and measles inclusion body encephalitis (MIBE). Due to rarity of disease and poor prognosis of LETM in patients, prompt diagnosis and treatment is of critical importance for a positive clinical outcome. We provide a comprehensive perspective of past and current literature in order to aid diagnosis and management of this rare phenomenon.

Keywords: Longitudinally extensive transverse myelitis, Measles, Rare.

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I. OBJECTIVE

Established as a viral disease, highly contagious and acute infectious, Measles is characterized by being a febrile exanthematous disease, caused by viruses of the family Paramyxoviridae, of the genus Morbillivirus, which has eight classes and 24 genotypes and the human being is its only reservoir and source of infection.[1,2]

The classic clinical condition is associated with fever, coryza, conjunctivitis, photophobia, morbilliform maculopapular rash, with cephalocaudal distribution, that is, it starts on the forehead, around the ears and neck, in the hairline and in the cranio-caudal direction, associated respiratory symptoms, such as dry cough. It presents tropism in the upper airways and can evolve with serious complications such as otitis, laryngitis, diarrhea, in addition to pneumonia and encephalitis, which are the main causes responsible for deaths [3]

LETM is a heterogeneous inflammatory disorder of the spinal cord characterized by acute or subacute development of motor weakness, sensory impairment, and autonomic dysfunction. Etiologies include idiopathic or secondary LETM which can be directly associated with infectious, systemic inflammatory or multifocal central nervous system disease. Despite the known neuro-invasive nature of measles virus the development of LETM is a rare manifestation. Few cases have been reported including the development of LETM at the initial time of presentation or subsequent development of LETM following recovery measles.

Only few cases of post measles mumps rubella vaccine (MMR) are reported.[4,5] In this report, we present a case with radiographic evidence of longitudinally extensive transverse myelitis in the patient with measles infection.

II. CASE PRESENTATION

A 8 year old male presented to pediatric emergency department, NIMS medical college, Jaipur with history of cough – coryza for 7 days, high grade fever for 7 days, rashes over body for 6 days and limb weakness for 2 days. Morbilliform maculopapular rash developed on day 2 of fever which started from neck area and than gradually involved the whole body. Limb weakness was gradual on onset, progressive and associated with sudden urinary incontinence. The patient denied any history of trauma. Patient had normal development history but he did not receive any vaccination in past.

On presentation, his vitals were the following: temperature 98.1 °F, pulse 74/min, blood pressure 102/64, respiratory rate 24/min and oxygen saturation (SpO2) of 99% on room air.

Neurologic exam on admission showed muscle strength of 0/5 strength in lower extremities and 4/5 strength in upper extremities. Deep tendon reflexes were absent in bilateral lower limbs and planter reflex was absent. He was conscious and oriented on admission. Rashes were in the stage of recovery at the time of presentation. Urinary bladder was distended due to retention of urine.

The remainder of the physical examination was within normal limits.

Brain magnetic resonance imaging (MRI) were negative for acute infarct or hemorrhage. Urgent MRI of the cervical and thoracolumbar spine were done which showed diffuse hyperintense T2 signal from the level of cervicomedullary junction up to lower thoracic vertebra level without any evidence of cord compression.

Cerebrospinal fluid (CSF) analysis showed a high white blood cell (WBC) count of 20 (ref. 0–5 cells/μL) with 15% neutrophils and lymphocyte count of 85%. CSF protein was high at 56 mg/dL (ref.15–45 mg/dL) and glucose was high at 203 mg/dL (ref.40–70 mg/dL). Measles antibody immunoglobulin M (Ab-IgM) and immunoglobulin G (Ab-IgG) were positive in blood and CSF in high titres. However, measles virus RNA in the spinal fluid, measured using the polymerase chain reaction method, was negative.

Bacterial cultures of the spinal fluid showed no growth. Human immunodeficiency Virus (HIV) serology, ANA - IFA were negative. The patient was started on 5 days of IV methylprednisone pulse therapy (30 mg/kg/day) followed by oral steroid therapy along with other supportive treatment. Patient showed significant clinical improvement. He was discharged to an extended care facility for physical therapy and neuro-rehabilitation after 2 wks of admission. At the time of discharge he had muscle power of 5/5 in upper limbs and 4/5 in lower limbs. On the 1month follow-up, the patient had further improvement in both his motor and sensory functions. Strength was 5/5 in the upper extremities as well as lower extremities.

Figure 1,2,3: T2W MRI spine shows T2 high signal extending from cervicomedullary junction up to the conus medullaris

III. DISCUSSION

Measles infection is an uncommon cause of transverse myelitis in immunocompetent patients. The pathogenesis of the nervous complications of measles is unknown. Many observers believe that there are acute inflammatory processes due to the neurotropism of the measles virus. Knebusch et al.[6] also suggested that there was a cellular autoimmune process against the myelin sheath of the central tracts that was more responsible than direct infection of the spinal cord. Early diagnosis of measles related myelitis is based on its temporal relationship to the rash and detection of measles RNA or measles specific antibodies or both in the CSF and blood. Magnetic resonance imaging of the spine may demonstrate T2 hyperintense lesions in the spinal cord with occasional swelling and enhancement.

Virologically confirmed cases of measles transverse myelitis are extremely rare. Analysis of available data reveals that approximately one-half of the patients with post measles myelitis recovered completely, approximately one-fourth were left with residual deficits, and about one-fourth died.[7] Currently, there are no established treatment regimens for transverse myelitis as a complication of measles infection. Some researchers recommend high doses of methyl-prednisolone for management and use of plasmapheresis in case no response to pulse steroid therapy. Although clinical recovery is variable, many immunocompetent patients improve significantly, though fatal cases have been reported.

IV. CONCLUSION

Measles and its neurological complications are preventable and must be prevented. Methylprednisolone pulse therapy appears to be a safe and effective treatment for children with transverse myelitis secondary to post-measles myelitis. More effective treatments for LETM may be available in the near future but currently this remain neurologically disabling disease.

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