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Individual and Environmental Determinants of the Consumption of Iron-Rich Foods among Senegalese Adolescent Girls: A Behavioural Model

Jérémie B. Dupuis ¹, Aminata Ndène Ndiaye ², Nafissatou Ba Lo ³, El Hadj Momar Thiam ³, Mohamadou Sall ² and Sonia Blaney ^{4,*}

¹ Office of the Vice-President Academic and Research, Université de Moncton, Moncton, NB E1A 3E9, Canada; jeremie.dupuis@umoncton.ca

² Institut de Recherche Population, Développement et Santé de la Reproduction/IPDSR, Université Cheikh Anta Diop, Dakar 10700, Senegal; litzamina@outlook.fr (A.N.N.); sallmoham@yahoo.fr (M.S.)

³ Conseil National de Développement de la Nutrition, Dakar 45001, Senegal; nlo@cndn.sn (N.B.L.); ethiam@cndn.sn (E.H.M.T.)

⁴ École de Nutrition, Université Laval, Québec, QC G1V 0A6, Canada

* Correspondence: soniablaney1@gmail.com

Abstract: To improve adolescent nutrition, it is crucial to understand factors underlying food behaviours. This study aims to identify pathways by which the environment and individual factors interact to affect the consumption of iron-rich food (IRF) among Senegalese adolescent girls in the hopes to reduce anemia. This is a cross-sectional study conducted among 600 adolescent girls (10–19 years old) of all 14 regions of Senegal. IRF consumption in the past day and night was evaluated using a food frequency questionnaire. Individual determinants, such as the attitude, the subjected norm, and the perceived behaviour control (PBC), and environmental determinants, such as food accessibility and price, were assessed using a validated and reliable questionnaire. Path analyses were conducted to examine relations between IRF consumption and individual and environmental variables. Overall, 83.7% of girls had the intention to eat IRF and 84.7% reported doing so. The PBC ($\beta = 0.20$, $p < 0.01$) and the attitude ($\beta = 0.57$, $p < 0.01$) predict the intention of consuming IRF daily. In turn, the environment predicts the attitude ($\beta = -0.22$, $p < 0.01$) and the PBC ($\beta = 0.26$, $p < 0.01$). The intention was a predictor of the IRF consumption ($\beta = 0.16$, $p < 0.05$). This research provides guidance to nutrition education programmes as well as to improve the food environment to facilitate the consumption of IRF among adolescent girls by inspiring community health initiatives based on empirical data.

Keywords: adolescent; girls; nutrition; iron-rich foods; determinants; consumption



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1. Introduction

Improving adolescent nutrition is a central component to achieve sustainable development goals. Quality diets are crucial for adolescents given their rapid growth and development. Adolescent girls require special attention given their high iron requirements due to menstrual losses and likelihood of pregnancy. Unfortunately, in past decades, adolescent nutrition has been overlooked [1] with the consequence that nutritional problems such as anemia persist among this group especially in low- and middle-income (LMIC) countries.

In Senegal, anemia (hemoglobin level lower than 12 g/dl [2]) among adolescent girls is a public health problem and it has stagnated in past decades [3,4]. About six out of ten adolescent girls (15–19 years) are anemic. One of the causes of this situation could relate to the limited intake of iron [5–7].

The available literature shows that dietary intake does not seem to be optimal among adolescent girls living in Senegal, especially iron intake. Studies have revealed that between 55% and 80% of Senegalese adolescents had inadequate iron intake [5,6] probably due

to the limited consumption of iron-rich foods, which has been estimated at about 60 g daily [7]. Results from Ndiaye et al.'s study [7] have also shown that fish was the most common food eaten by adolescent girls followed by beef meat, chicken, and eggs. The limited consumption of iron-rich food put girls at risk of iron deficiency anemia, which may have consequences on their cognitive ability, physical endurance, and immunity. Given the high prevalence of anemia among Senegalese adolescent girls, it is imperative to address potential factors that could help at improving the consumption of iron-rich foods.

To be successful, nutrition interventions with adolescents should resonate with their values and social context [1]. In many contexts, the food environment, social norms, and individual factors such as knowledge, beliefs, and autonomy are drivers of adolescent food behaviours [8]. As pointed out by Bryan et al. [9], it is vital to understand factors associated with adolescent behaviours and address them in designing effective programmes and policies. Yet, to promote positive behaviour changes among adolescents, more evidence is needed to inform comprehensive context-specific strategies especially in LMIC countries [10]. To help investigate what shapes adolescent food choices, behavioural theories are invaluable.

Among adolescents, the theory of planned behaviour (TPB) has been used to understand what could explain their food choices [11–14]. According to the TPB, the intention is the key predictors of a behaviour [15]. In turn, the attitude, the subjective norm, and the perceived control influence the intention [15].

To our knowledge, no research has investigated individual and environmental factors alone or simultaneously, as well as the relationship between these factors, to determine what influences the consumption of iron-rich foods among adolescent girls in LMIC including in Senegal. Using the extended version of the TPB [16], this study aims to explore pathways where individual factors, such as the attitude, subjective norm and the perceived behavioural control, and environmental factors influence the consumption of iron-rich foods (IRF) among Senegalese adolescent girls. This research will contribute to define behaviour change and/or environmentally related effective interventions that could help alleviate anemia and iron deficiency among this group.

2. Methods

2.1. Design and Sampling

As described in part one of this research [17], a cross-sectional design was used for this study. In each of the 14 regions of Senegal, all census units were listed. A total of 100 census units were selected at random in proportion to the population size of each region. Thereafter, in each unit, the inventory of every household with at least one adolescent girl (10–19 years old) was conducted and eleven households were selected randomly. The calculation of the sample size was based on the expected proportion of adolescent girls who had eaten any IRF the day or night before this study using the following formula [18]: $n = t^2 \times p(1 - p)/m^2$ where there is t (confidence interval at 95% = standard value of 1.96), a p (expected prevalence in the areas) of 50% [15], and an m (relative precision) of 0.05. A design effect of 1.5 was used. The total number of adolescent girls required was 576. Every adolescent girl aged 10–19 years old, living in each selected household, was invited to participate in the survey. Pregnant and lactating adolescent girls were excluded.

2.2. Preparatory Work

After recruiting local enumerators, they were trained on survey tools, the methodology, as well as on the theory behind the study with in-class sessions and field practice exercises.

2.3. Theoretical Framework

As reported previously [17], the extended TPB (eTPB) [9,16] guided this study. In short, the TPB postulates that the intention of an individual is the most important predictor of a behaviour. However, the intention is determined by (a) the attitude, or the individual's beliefs about adopting and the evaluation they make about possible consequences, (b) sub-

jective norm, the importance given by an individual to the opinion of people or groups of people around them (normative beliefs) and the motivation to comply with their views, and (c) perceived behavioural control (PBC), which is the degree of control the individual beliefs (control beliefs) can exert over a behaviour added to their perception of the easiness or difficulty in having the behaviour be adopted [18,19]. Environmental factors are external influencers. They include sociodemographic characteristics that may affect the attitude, the subjective norm and the PBC through moderation and the transformation of the intention to an actual behaviour [20].

2.4. Data Collection

Data were collected in August and September 2023. Supplementary Material S1 presents a flowchart, which provides a visual summary of the data collection and analysis process.

Information on the consumption of IRF was gathered through a face-to-face interview with each adolescent girl using the food frequency questionnaire, utilized to assess the minimum dietary diversity among women aged 15–49 years old [21]. Demographic and Health Survey Questionnaires [12] (household and women questionnaires) were adapted and utilized to collect data on households such as the size, age, gender, and level of education of the head/adolescent's mother; housing conditions; ownership of assets; access to an improved water source and sanitation; access to health services; region; and urban/rural residence. Measured adolescent characteristics were age, religion, ethnic group, relationship with the head of the household, current marital status, level of education and literacy, perception of health status, if she had fever and parasites in feces in the past two weeks, if she had received a dewormer and iron supplementation in the past 6 months, her exposure to media, whether or not she had menstruations, and hand-washing habits. Data on household food security were collected using the food insecurity experience survey FAO module [22]. Face-to-face interviews were done with the adolescent girl and the head of the household to gather the previously enumerated characteristics.

For each construct of the eTPB framework, data were collected using a validated and reliable questionnaire [17]. This tool includes 30 items spread out as follows: 1 item on the intention, 9 items on the attitude, 13 items on the subjective norm, 4 items on the PBC, and 4 items on the environment. As for information on the consumption of IRF and sociodemographics, data were collected through a face-to-face interview with each adolescent girl who was invited to point out her answer to each item on the Likert scale after its reading by the surveyor. This method was used to ensure that participants with differing literacy levels could participate.

2.5. Data Analysis

2.5.1. Behaviour of Interest

If the participant had consumed at least one IRF, such as eggs, beef, pork, lamb, chicken, liver, heart, other organs, fish and shellfish, in the past day or night [23], she was assigned a score of 1. If none was consumed, a score of zero was given.

2.5.2. Measurement of the Framework's Constructs

Data were entered into SPSS [24]. For every item of the questionnaire, a score was assigned to each response on the Likert scale, spreading from −2 (e.g., strongly disagree/unlikely/disapprove) to +2 (e.g., strongly agree/likely/approve).

To assess each construct, direct and indirect measures were used [25,26] as the latter could be a valuable source of information to help understand what drives behaviour while direct measures are more associated with the intention [26]. Therefore, for each measure (direct and indirect) of every construct, the mean score was calculated by averaging the score of all related items. Yet, before calculating the mean, scores were reversed for items in which a positive response did not indicate a positive perception toward the behaviour. For example, if the adolescent girl's response was in total agreement (score of +2) with the following item "IRF can cause me illnesses", the score of +2 was replaced by −2.

Spearman correlations were performed to investigate bivariate associations between the (1) categorical score of individual items and mean score of direct and indicated constructs, (2) mean score of indirect and direct constructs, and (3) categorical (attitude) or mean scores (subjective norm, PBC, environment) of each direct construct and the intention (categorical measurement).

Path analyses were performed with MPlus 8 [27] to evaluate the relationships through which individual and environmental factors may influence the behaviour under study. Figures 1 and 2 propose the two hypothesized pathways whereby each construct could determine the consumption of IRF. In Figure 1, the environment predicts (arrows) the attitude, the subjective norm, and the PBC. Correlations (curved lines) between these last three constructs are postulated, and all three of them predict the intention. Finally, the behaviour is predicted by the intention and the PBC. In Figure 2, instead of the environment predicting the attitude, the subjective norm, and the PBC, the environment is simply correlated with the intent, meaning that the more favourable the environment, the more likely the intent.

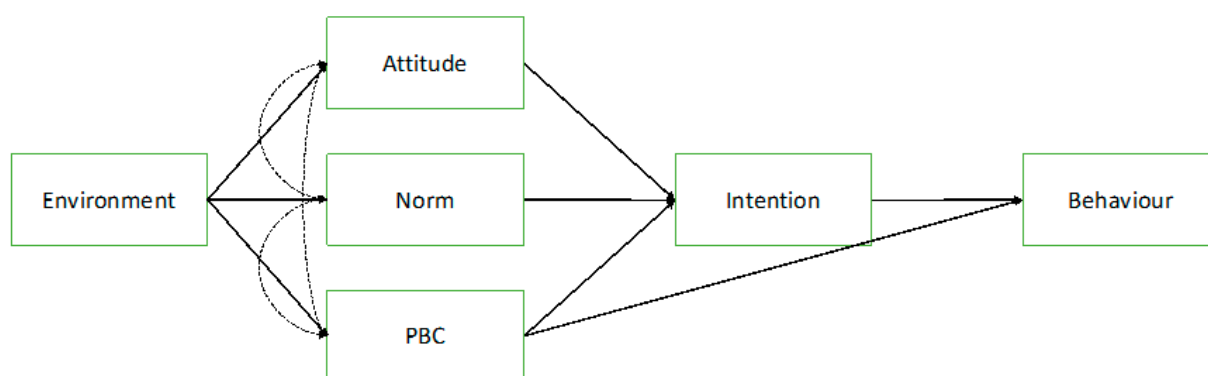


Figure 1. Hypothesized pathways between psychosocial factors (attitude, norm, and perceived behavioural control/PBC) and the environment (ENV), the intention (intent), and the behaviour: arrows represent postulated predictions between constructs while curves represent potential correlations.

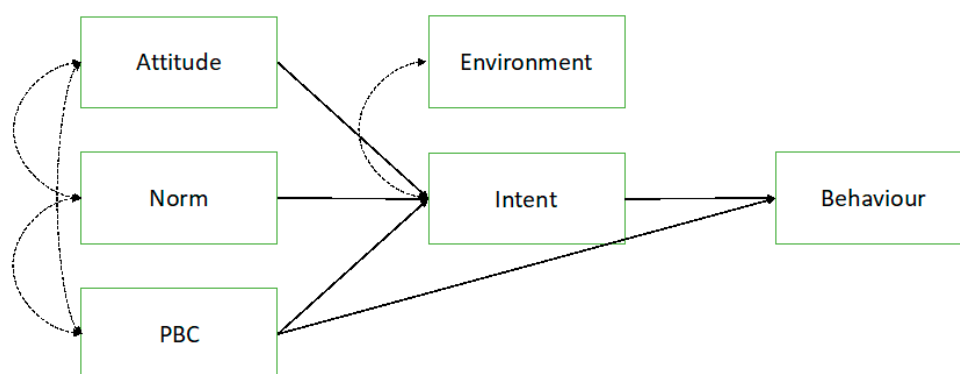


Figure 2. Hypothesized pathways between psychosocial factors (attitude, norm, and perceived behavioural control/PCB), the environment (ENV), the intention, and the behaviour: arrows represent postulated predictions between constructs while curves represent potential correlations.

As for the measurement of the constructs themselves, they represent latent variables created with the mean scores of the individual items from that construct. More details about the process used to obtain these constructs can be found in Ndiaye et al.'s work (2024) [17]. In the analysis with MPlus 8 [27], as there was a mixture of continuous and categorical variables, the weighted least squares (WLSMV) were used as the estimator and categorical variables were specified.

To assess the final model fit, the following indicators and criteria were used: (a) the comparative fit index (CFI) and Tucker–Lewis index (TLI) with a value greater than 0.95,

(b) the Root Mean Square Error of Approximation (RMSEA) and its 90% confidence interval below 0.08, and (c) the standardized root mean square residual (SRMR) of 0.08 or below [28]. For the final model to be acceptable, all postulated pathways had to be statistically significant ($p < 0.05$). To do so, the Wald test was used to remove nonsignificant pathways, while the Lagrange Multiplier method [27] was used to guide the authors in adding pathways, but theoretical considerations remained the main source of inspiration for new paths. Standardized regression coefficients were estimated for all significant pathways.

2.5.3. Sociodemographic Characteristics

To obtain a socioeconomic score for each household, a factor analysis with the principal axis factoring method was used with the 23 items on household assets. Items with little variation in the distribution of the scores were eliminated. More specifically, items for which 85% or more of households had the same answer were removed, as these types of items have limited discriminatory power. In total, 17 items were included in the final score: material of the floor's house; ownership of horses/donkeys, goats, muttons, and chickens; owns agricultural land and a bank account; has electricity; and owns a radio, television, computer, watch, bicycle, motorcycle, and cart with an animal. Together, these explain 24.15% of the total variance and composition of the score. The result of the Kaiser–Meyer–Olkin test was 0.826, which is very good [29]. As for the household food security status, a value of “1” to each item was attributed if the response was yes, while a score of “0” was allocated if the answer was no. A household was classified as being food-secure if the sum of all numeric values to each item was zero and as food-insecure if the total ranged from 1 to 8 [22]. Access to an improved water source and sanitation was assessed using WHO indicators [30]. Chi-square and Fisher's exact tests were performed to appraise differences in proportions of adolescent girls who had consumed IRF between categories of adolescent and household characteristics. Sociodemographic characteristics with significant differences ($p < 0.01$) between categories with regards to the consumption of IRF were considered in the path analysis at the same level compared to the environment as per the theoretical framework.

3. Results

3.1. Population's Characteristics

Data on sociodemographic characteristics of adolescent girls as well as differences between proportions of them who had consumed IRF the past day or night for each characteristic are presented in Table 1. Most girls were Muslim and either from the Wolof or Peul ethnic group. About 2/3 were able to read a full or a part of a sentence while 4 out of 5 were watching television at least once a week or less than one time per week. About 50% of their mothers had no formal education. One out of five girls had received iron folic acid supplements or a dewormer in the past six months.

Table 1. Sociodemographic characteristics of adolescent girls (n = 600).

Characteristics	N	%	% Who Had Consumed IRF	p-Value
Individual				
Age (years)				
10–14	293	48.8	80.5	0.009
15–19	307	51.2	88.3	
Religion				
Muslim	575	95.8	84.9	0.495
Christian	23	3.8	73.9	
Animist	1	0.2	100	
No religion	0	0.0	0	
Other	1	0.2	100	

Table 1. Cont.

Characteristics	N	%	% Who Had Consumed IRF	p-Value
Ethnic group				
Wolof	204	34.0	88.7	0.186
Peul	192	32.0	79.2	
Serere	81	13.5	85.2	
Mandingue	47	7.8	87.2	
Diola	21	3.5	85.7	
Soninke	22	3.7	90.9	
Others/non-Senegalese	33	5.5	78.8	
Relationship with head of HH				
Daughter	427	71.2	85.2	0.195
Grand-daughter	129	21.5	85.3	
Other	44	7.3	75.0	
Marital status				
Currently married/with a partner (vs. not married) *	65 (535)	10.9 (89.2)	78.5 (85.2)	0.170
Level of education				
No formal education	135	22.5	82.2	0.093
Some primary	196	32.7	79.6	
Primary completed	186	31.0	88.2	
Some secondary	79	13.2	91.1	
Secondary completed	3	0.5	100.0	
More than secondary	1	0.2	100.0	
Literacy				
Able to read a full/part sentence aloud (vs. not able) *	405 (195)	67.5 (32.5)	87.2 (79.0)	<0.001
Health status perception				
Very good	163	27.2	86.5	0.714
Good	254	42.3	83.9	
Average	159	26.5	82.4	
Bad	23	3.8	91.3	
Very bad	1	0.2	100.0	
Had malaria/fever < 2 weeks (vs. no malaria) *	37 (563)	6.2 (93.8)	97.3 (83.7)	0.026
Presence of parasites in feces < 2 weeks (vs. no parasites) *	38 (562)	6.3 (93.7)	76.3 (85.1)	0.116
Received a dewormer < 6 ms (vs. not received) *	120 (480)	20.0 (80.0)	84.2 (84.5)	0.828
Received IFA supplements < 6 ms (vs. not received) *	145 (455)	24.2 (74.8)	84.8 (84.4)	0.988
Exposure to mass media at least once a week				
Reads newspapers (vs. not at all/less than once a week) *	32 (568)	5.3 (94.7)	93.8 (84.0)	0.206
Watches TV (vs. not at all/less than once a week) *	440 (160)	73.3 (26.7)	88.0 (75.0)	<0.001
Listens to radio (vs. not at all/less than once a week) *	110 (490)	18.3 (81.7)	87.3 (83.9)	0.389
Household				
Level of education of the mother				
No formal education	307	49.2	83.7	0.249
Some primary	126	21.0	80.2	
Primary completed	46	7.7	78.3	
Some secondary	110	18.3	92.7	
Secondary completed	6	1.0	83.3	
More than secondary	5	0.8	100.0	
Socioeconomic quintiles				
Lowest	120	20.0	92.5	0.001
Second	120	20.0	86.7	
Middle	120	20.0	90.0	
Fourth	120	20.0	83.3	
Highest	120	20.0	70.0	

Table 1. Cont.

Characteristics	N	%	% Who Had Consumed IRF	p-Value
HH size				
3–4	47	7.8	89.4	0.327
5–6	101	16.8	89.1	
7–8	105	17.5	79.0	
9–10	100	16.7	88.0	
11–12	70	11.7	82.9	
13–14	48	8.0	85.4	
≥15	129	21.5	81.4	
Age of head of HH				
20–29	12	2.0	75.8	0.308
30–39	74	12.3	78.4	
40–49	141	23.5	86.5	
50–59	154	25.7	81.8	
60–69	108	18.0	87.0	
≥70	111	18.5	88.3	
Male as the sex of head of HH (vs. female) *	463 (137)	77.2 (22.8)	82.9 (89.8)	0.052
Food security status				
Food secure (vs. food insecure) *	186 (414)	31.0 (69.0)	92.5 (80.9)	<0.001
Access to improved water (vs. no access) *	525 (75)	87.5 (12.5)	86.3 (72.0)	0.001
Access to improved sanitation (vs. no access) *	504 (96)	84.0 (16.0)	87.3 (69.8)	<0.001
Region				
Dakar	152	25.3	87.5	0.007
Ziguinchor	31	5.2	87.1	
Diourbel	61	10.2	93.4	
Saint-Louis	47	7.8	87.2	
Tambacounda	36	6.0	72.2	
Kaolack	39	6.5	84.6	
Thiès	76	12.7	92.1	
Louga	34	5.7	64.7	
Fatick	36	6.0	86.1	
Kolda	30	5.0	76.7	
Matam	13	2.2	69.2	
Kaffrine	16	2.7	75.0	
Kédougou	7	1.2	85.7	
Sédhiou	22	3.7	77.3	
Residence rural (vs. urban)	308 (292)	51.3 (48.7)	79.2 (90.1)	<0.001
Access to a health facility ≤30 min of distance (vs. no access) *	519 (81)	86.5 (13.5)	86.9 (69.1)	<0.001

* For each characteristic, comparisons using chi-square or Fisher's tests were performed between proportions listed outside and within the bracket. n = 470.

3.2. IRF Intake

In total, 84.5% of adolescent girls had consumed IRF the past day or night. Proportions of girls who had consumed IRF were higher among those aged 15–19 years old as well as among girls able to read a full/part of a sentence, watching TV at least once a week, and living in a food-secure household with access to an improved water source, sanitation, and a health facility as well as among those living in an urban area (Table 1). Proportions of adolescent girls consuming IRF who were living in households in the lowest socioeconomic quintiles were somewhat higher than that in the highest quintile (Table 1).

3.3. Associations between the Intention, Questionnaire's Individual Items, and Direct and Indirect Measurements of the Theoretical Constructs

Overall, almost 85% of adolescent girls had the intention to consume IRF every day (Supplementary Material S2). More than 80% agree that consuming IRF each day will allow them to be in good health, to grow, to prevent anemia, and to provide them with vitamins. About 30% of girls either disagreed or had a neutral position with regards to the fact that adopting the behaviour can cause illnesses and problems during menstruation. Mean scores for direct and indirect measurements of the attitude construct were 1.23 (standard deviation: ± 0.81) and 1.00 (± 0.57) out of a maximum of 2.

About 80% and 70% of adolescent girls believe that their mother and their father, respectively, will approve/strongly approve if they consume IRF each day (Supplementary Material S2). In addition, around 60% of girls perceived that their sisters, aunts, and friends will approve if they adopt the behaviour. About one out of two adolescents perceived that their cousins (male), grandfather, and grandmother will neither approve/disapprove if they consume IRF daily. Mean scores for the direct and indirect measurements were 0.71 (± 0.95) and 0.90 (± 0.72), respectively.

Slightly more than 50% of adolescent girls reported that they feel able to consume IRF every day while only 40% reported that it would be easy to do so (Supplementary Material S2). However, with regards to control beliefs, 87% of them reported that if they had more money, they would be able to consume IRF daily. For 67% of them, having more control over what is cooked at home could make them able to consume IRF each day. Mean scores for the direct and indirect measurement of the PBC were 0.06 (± 1.19) and -0.93 (± 0.81), respectively.

With regards to the environment, the high price of IRF was reported as a barrier to their consumption by almost 75% of girls. Additionally, the fact that IRF are not cooked at home every day or that a sufficient quantity is not prepared was also reported by approximately 60% of girls. One out of two adolescent girls reported that their parents/tutors were not giving them enough money for buying IRF. The mean score for the environment construct was -0.57 (± 0.86) (Supplementary Material S2).

Results of the correlations between items of the questionnaire are presented in Supplementary Materials 3a–c. These include direct and indirect measurements of each construct of eTPB. Supplementary Material S3d shows results between the intention and direct and indirect measurements. For the attitude (Supplementary Material S3a), apart from the associations between items 3.7 (IRF can cause illnesses...) and 3.8 (IRF can cause problems during menses) and the indirect measurement of the construct, all bivariate correlations were significant ($p < 0.01$). For the subjective norm and the PBC, all individual items were correlated with the direct and indirect measurements of the construct (Supplementary Materials S3b,c). For each construct, direct and indirect measures were also correlated (Supplementary Material S3d). Moreover, direct and indirect measurements of each construct were associated with the intention ($p < 0.01$). Apart from the bivariate relation between the direct measurement of the subjective norm and the environment, all direct measurements of each construct (the attitude, subjective norm, PBC, and environment) were correlated with each other ($p < 0.01$).

3.4. Final Path Models

Results of the final path analysis including standardized regression coefficients are presented in Figure 3. In addition, values of fit indices of the initial and final models are presented in Table 2. In the first hypothesized pathways (Figure 1), as per the theoretical framework, we stipulated that the intention predicts the behaviour, and in turn, the intention is predicted by the attitude, the subjective norm, and the PBC. Finally, it was hypothesized that these three constructs were under the influence of the environment. Correlations were also presumed between each pair of constructs. Results of the path analysis did not provide acceptable fit indices as shown in the initial model (Table 2) and some associations within this proposed model were nonsignificant. Therefore, nonsignificant associations were removed step by step as eliminating one association may affect how

others interact, all while improving model parsimony. Environment and subjective norm association was the first to be removed followed by PBC and the behaviour. Given that the subjective norm did not predict the intention, this association was also removed. All remaining associations were significant, and the model yielded acceptable fit indices for most measures (Table 2 and Figure 3). In the final model, the intention of consuming IRF each day is a positive predictor ($\beta = 0.16$, $p < 0.05$) of the actual behaviour, although this association is quite weak. A possible explanation for this result is given in the discussion. In turn, the intention was more strongly predicted by the attitude ($\beta = 0.57$, $p < 0.001$) than the PBC ($\beta = 0.20$, $p < 0.001$), but both are positive predictors of intention. The social norm does not predict the intention. The environment negatively predicts the attitude ($\beta = -0.22$, $p < 0.001$) and positively the PBC ($\beta = 0.26$, $p < 0.001$). Correlations between the individual constructs are significant. The addition of sociodemographic characteristics did not change the indices of the final model.

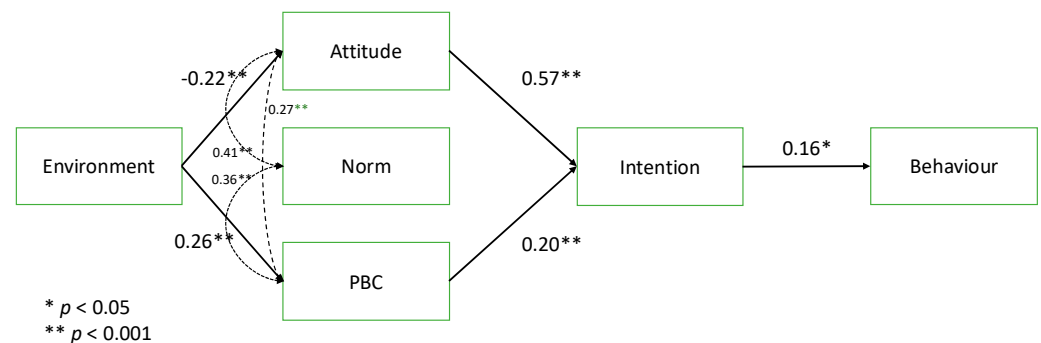


Figure 3. The final model of the hypothesized pathways between psychosocial factors (attitude, norm, and perceived behavioural control/PBC), the environment, the intention, and the behaviour: arrows represent postulated predictions between constructs while curves represent potential correlations.

Table 2. Fit indices for the initial and final model ($n = 600$).

Indices *	Initial Model	Final Model
χ^2	16.43	21.05
df	4	7
p	0.003	0.004
RMSEA	0.07	0.06
90% C.I.	0.04–0.11	0.03–0.09
p	0.130	0.285
CFI	0.98	0.98
TLI	0.94	0.96
SRMR	0.04	0.05

* χ^2 : chi-squared test value; df: degree of freedom; RMSEA: root mean square error of approximation; CI: confidence interval; CFI: comparative fit index; TLI: Tucker–Lewis index; SRMR: standardized root mean square residual.

With regards to the second hypothesized pathways (Figure 2), after testing this model, the correlation between the intention and the environment was nonsignificant, rendering this correlation model invalid.

4. Discussion

This study used the extended theory of planned behaviour to identify pathways in which individual factors (attitude, subjective norm, PBC) and the environment interact to influence the daily consumption of IRF among Senegalese adolescent girls.

Our findings indicate that 85% of girls had consumed IRF the day or night before the survey. Our result is similar to that of Wiafe et al. [31], who also found that 87% of adolescents (male and female combined, $n = 137$) aged 10–14 years old living in two rural communities of Ghana had consumed meat/fish/poultry the past 24 h while 7% had eaten eggs. However, in our study areas, even though the proportion of girls who had consumed IRF the past day or night was elevated, the quantity might be limited as per Ndiaye et al.'s [7] estimate of 58 g ($SD \pm 33$) among urban Senegalese adolescent girls ($n = 136$) and thus might not be sufficient to fulfil iron requirements.

Among our population, the intention was somewhat translated into the actual behaviour as 84% of adolescent girls reported that they intend to consume IRF each day while 85% did consume at least one IRF the past day or night. This result was expected given that a central feature of the TPB is that the stronger the individual's intention to perform a behaviour, the more likely it will be implemented if the behaviour in question is under volitional control [15]. Our results corroborate this theory, but the dichotomous nature of the measure for these two constructs may explain the model's inability to find a stronger association between the two, as subtleties in intentions and behaviours are overlooked.

Having a positive attitude toward the behaviour, such as believing about benefits that could be provided by IRF, increases the intention to consume them. Although limited nutritional knowledge has been pointed out by Fleming et al. [8] as an issue to optimal nutrition among adolescents, Senegalese adolescent girls believe in positive benefits with regards to the advantages of consuming IRF each day, such as keeping them healthy, making them less tired, and anemia prevention. Similar to our findings, eggs and fish were perceived as being healthy by adolescent girls in Bangladesh, but they then also reported that the consumption of IRF such as fish should be reduced or eliminated during menstruations as it may create problems [32].

Likewise, if adolescent girls perceive that they can overcome barriers such as receiving more money to buy IRF or having more control over foods that are cooked at home, their intention to eat IRF daily will improve. The limited control by girls over financial resources they receive or over the home food preparation was also highlighted by Reese-Mastersen et al. [33] among Zimbabwean adolescent girls aged 13–19 years old for whom the mother was identified as the primary decision-maker surrounding food purchases and food preparation. However, in different settings, in Pakistan and Bangladesh, adolescent girls also stated that the lack of economic resources was an obstacle to the consumption of healthy foods [32,34].

It has been reported that the subjective norm such as that of the peer group or family/parental/sibling perceived norms may be a source of influence over adolescent eating behaviour or intention [35]. As pointed out by Stok et al. [36], studies using the TPB have also shown that subjective perceptions of normative expectations may often be weakly associated with the intention among adolescents. Yet, in our setting, the subjective norm was not a predictor of the intention of girls to consume IRF each day. Is it because this study was conducted during vacation time so perhaps the subjective norm such as that from peers would have been more influential during the school period and was not captured at the time of our data collection or is it a limitation of our measurement of the subjective norm? This question deserves further investigation.

It appears that the more supportive the environment, the more adolescent girls perceive that they have control over the behaviour. In other words, if environmental barriers are lifted, they might feel more capable to consume ARF every day. The environment was a predictor of the attitude, but the relationship was negative. This means that the less favourable the environment, the more positive the girls' attitude to the behaviour will be to consume IRF. It is possible that IRF are appealing because of their higher price and low availability at home, resulting in a favourable attitude towards these foods. This might be the case. As reported in a systematic review conducted by Caspi et al. [37], most expensive foods were associated with a healthier diet. In fact, it is possible that if one perceives food as being of good quality, they may feel that it is more appealing.

As expected, direct measurements of each construct were generally correlated more strongly with the intention than indirect measures [26]. Yet, items under indirect measurements contribute to explain what drives the behaviour and thus could be of use to design behaviour change communication interventions.

Findings from our study reiterate the need to implement a package of interventions and a multisectoral coordination to improve the consumption of IRF among adolescent girls. To promote behaviour change among adolescent girls, it is crucial to address both individual and environmental factors. In fact, our results show that although behavioural-change communication interventions are certainly needed to maintain and improve adolescent girls' knowledge, attitudes, intention, and behaviours to increase their consumption of IRF, actions are also crucial to create supportive environments such as identifying ways to improve their access to financial means and their control over foods cooked at home, to enhance the availability and accessibility to these foods. Because adolescents spend a large share of their time in school, this setting could be used as a platform to deliver nutrition education. However, through the health setting, health professionals could also be a source of nutrition advice for adolescent girls. Actions are also needed to improve household resources as some families struggle to acquire healthy foods. Our research also emphasizes the relevance of bestowing CNDN as a governmental body in charge of implementing multisectoral interventions and programmes to enhance adolescent nutrition in Senegal.

Our study has several strengths that should be recognized. First, a validated and reliable questionnaire has been used to collect data on factors that may influence the daily consumption of IRF. Second, to our knowledge, this is the first research to simultaneously investigate individual and environmental factors related to the consumption of IRF among adolescent girls. Our findings also provide guidance for developing/improving the efficiency of programmes and strategies on adolescent nutrition to address individual and environmental barriers that may limit the consumption of IRF. As for some limitations to our study, given the dichotomic nature of the measurement of the consumption of IRF among adolescent girls, this may have limited the ability of the path analysis to explain the variance associated with the behaviour. Moreover, the consumption of IRF has been evaluated only for the past day or night and may not reflect the usual IRF intake. The cross-sectional design of our study also leaves the possibility that beliefs and environmental barriers may have shaped the behaviour over time, thus not reflecting the actual situation. As pointed out earlier, this study was conducted during summer vacations, not during the school period and thus the influence of the food environment over the different constructs of the extended TPB as well as the impact of the subjective norm on the intention may have been different if the research would have been conducted during the school year [38–40]. Finally, our findings cannot be generalized to all adolescents as males were not included and they may have a different eating pattern regarding IRF consumption [41].

5. Conclusions

Findings from our research suggest that the intention of consuming IRF each day predicts the behaviour while in turn, the intention is predicted by the attitude and the perceived behavioural control, both under the influence of the environment. To improve the consumption of IRF, a multisectoral and coordinated approach is required given the complexity of underlying determinants that may influence the behaviour. The active participation of adolescent girls in the design and implementation of interventions is central to reach them at the right place with the appropriate interventions at the right time.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/adolescents4030028/s1>. S1: Flow chart of the research process. S2: Frequency distributions (%) of answers and mean scores ($\pm$ standard deviation/SD) for each item of the questionnaire. direct and indirect measurements of each construct and the intention (n = 600). S3a: Spearman correlations between individual items on behavioural beliefs, direct (DM) and indirect measurements (IM) of the attitude construct (n = 600). S3b: Spearman correlations between individual items on subjective norm beliefs, direct (DM) and indirect measurements (IM) of the subjective norm construct (n = 600). S3c: Spearman correlations between individual items on control beliefs, direct (DM) and indirect measurements (IM) of the perceived behavioural control construct (n = 600). S3d: Spearman correlations between direct (DM) and indirect (IM) measurements of each construct (attitude/ATT, subjective norm /SN, perceived behavioural control/PBC, environment/ENV and the intention/INT (n = 600).

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Informed Consent Statement: Verbal consent/assent was obtained from all participants. Verbal consent was witnessed and formally recorded. Participation was voluntary and participants could withdraw from the study at any time without negative consequences or prejudice as well as without justifying their decision.

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