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EFFECTIVENESS OF BIRTAN FOOD-BASED TRAINING ON SECONDARY SCHOOL TEACHERS AT PIRGONJ UPAZILA UNDER RANGPUR DISTRICT, BANGLADESH

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ABSTRACT

The study aimed to assess the effectiveness of BIRTAN food-based training on secondary school teachers in Pirgonj Upazila, Rangpur District, Bangladesh. The specific objectives were to determine the characteristics of the respondents, evaluate the extent of effectiveness of the food-based training, and explore how selected teacher characteristics influence training effectiveness. The research used a quantitative approach with a sample of 172 secondary school teachers selected through simple random sampling from a population of 310. Data collection tools included an interview schedule measuring three dimensions of training effectiveness: information received, understanding, and application, each rated on a 4-point scale. Data were analyzed using descriptive statistics, correlation coefficients, and multiple regression in SPSS. Findings revealed that most teachers had moderate effectiveness from the training, with 60% showing medium effectiveness levels and only 17.4% achieving high effectiveness. The study identified significant positive relationships between training effectiveness and factors such as educational qualification, physical mobility, training received, and knowledge of food and nutrition, while age had a slight negative effect and professional experience was not significant. The regression model explained 41.6% of the variance in training effectiveness, highlighting the importance of these characteristics in enhancing training outcomes. The study recommends improving food-based training programs by emphasizing educational qualifications, physical mobility, and nutrition knowledge of teachers during planning and implementation to increase effectiveness. Strengthening these factors could better equip teachers to apply nutrition knowledge in their professional and personal lives, thereby supporting improved nutritional awareness in the school community.

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INTRODUCTION

Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN) is established to raise awareness across all segments of the population about the importance of food-based nutrition, primarily through training and research. Training includes human resource development in food-based nutrition through trainer training and awareness-

raising among the general public. Cereals, largely rice, are the main food in Bangladesh. Nearly two-thirds of the daily diet consists of rice, some vegetables, a small quantity of pulses, and small quantities of fish if and when available. Milk, milk products and meat are consumed only occasionally and in very small amounts. Fruit consumption is seasonal and mainly includes papaya and banana, which are cultivated

year-round. The dietary intake of cooking oil and fat is meagre. The typical rural diet in Bangladesh is, reportedly, not well balanced.(Bhattacharjee et al., 2007)

Despite considerable improvements in the national rural health status, the nutritional well-being of rural people remains neglected. Children and women in Bangladesh suffer from high levels of malnutrition and micronutrient deficiencies such as low birth weight (LBW), undernutrition (underweight, stunting and wasting), vitamin A deficiency, iodine-deficiency disorders (IDD) and iron-deficiency anemia (IDA). At the same time, new health problems related to over-nutrition such as obesity are emerging (Bhattacharjee et al., 2007).

To address the problem of malnutrition, food and nutrition education should be extended to everyone from children to older adults through both formal and informal education. In the context of formal education, schools play a vital role as appropriate institutions for implementing food and nutrition education. Within the school environment, pedagogical practices can support the learning process and improve quality of life. Education shapes individuals into informed, critical-thinking citizens, capable of understanding various aspects of life and society, including essential topics such as food and nutrition.(Albuquerque et al., 2013).

Nutrition education should be sequential, with adequate duration and intensity to be effective (Roseman et al., 2011). It equips young people with the knowledge and skills necessary to make healthy food choices and develop lifelong eating habits. Schools are ideal environments for delivering this education, as they reach the majority of youth and allow nutrition topics to be integrated across various subjects such as health, science, and consumer studies (Story et al., 2002). School-based nutrition programs also support broader health-promotion initiatives among students, teachers, and staff (Kupolati et al., 2019).

Teachers play a critical role in implementing nutrition education, either independently or in collaboration with professionals and researchers (Blom-Hoffman et al., 2004). They influence students' eating behaviors through role modeling, rewards, and their attitudes toward healthy living (Katsagoni et al., 2019). When teachers deliver nutrition lessons, they are responsible for improving students' nutrition knowledge, self-efficacy, and behaviors similar to their roles in teaching traditional subjects like math or science (Roseman et al., 2011).

Despite their central role, many teachers feel unprepared to teach nutrition effectively. Barriers include a lack of pre-service and in-service nutrition training, limited

opportunities for professional development, and perceptions that nutrition education does not align with national curricula (Dunn et al., 2019; Snelling et al., 2016; Thackeray et al., 2002). Teachers with limited knowledge of nutrition are less likely to emphasize the subject, and time or curriculum constraints further reduce its presence in the classroom.

Several studies and reviews have evaluated the effectiveness of school health and nutrition (SHN) programs globally, with findings supporting the impact of multi-component, school-based nutrition interventions (SBNI) in improving nutrition status as well as nutrition-related knowledge, attitudes, and behaviors (Kyerere et al., 2020). Nutrition education programs that deliver positive dietary messages have also been shown to increase children's nutrition knowledge and improve their dietary behaviors (Powers et al., 2005). To ensure effective implementation of such behavior change curricula in the classroom, teacher training should be conceptualized as a behavior change process that includes explicit components for teacher motivation. Additionally, forming a collaborative team involving education and health departments comprising educators, nutritionists, and public health experts can be beneficial in designing and testing nutrition education curricula for primary and secondary schools (Pérez-Rodrigo & Aranceta, 2001). Therefore, the study is being undertaken by considering the following objectives:

- i) To determine the selected characteristics of the respondents'
- ii) To assess the extent of effectiveness of food-based training on secondary school teachers
- iii) To explore the influence of the selected characteristics of the respondents on food-based training of secondary school teachers.

METHODOLOGY

Study area

The survey of the research study was executed at the Pirgonj upazila of Rangpur district. The proposed study areas are given in the Figure 1.

Population and sampling

School teachers in the proposed study areas were the study population. An appropriate sample and reserve list was determined to avoid uncertainty related to sample availability during data collection. Considering the study intends to have a statistically significant and comparable set of results for the study areas, the sample size for the research was calculated using the following formula (Kothari, 2004):

$$n = \frac{Z^2 P Q N}{(n-1)e^2 + Z^2 p q}$$

Where,

n= Sample size

Z= 1 the value of the standard normal variable at the chosen (95 percent) confidence level (1.96)

P= Probability (assume 0.5)

Q = Remaining probability (1-P)

N = Total population

e = the level of precision (5 percent)

Using the above formula, a sample of 172 school teachers was selected from a population list of 310 using simple random sampling techniques. Besides this, a reserve list of 17 school teachers was prepared, who were to be interviewed only when a respondent in the original sample list was unavailable during data collection.

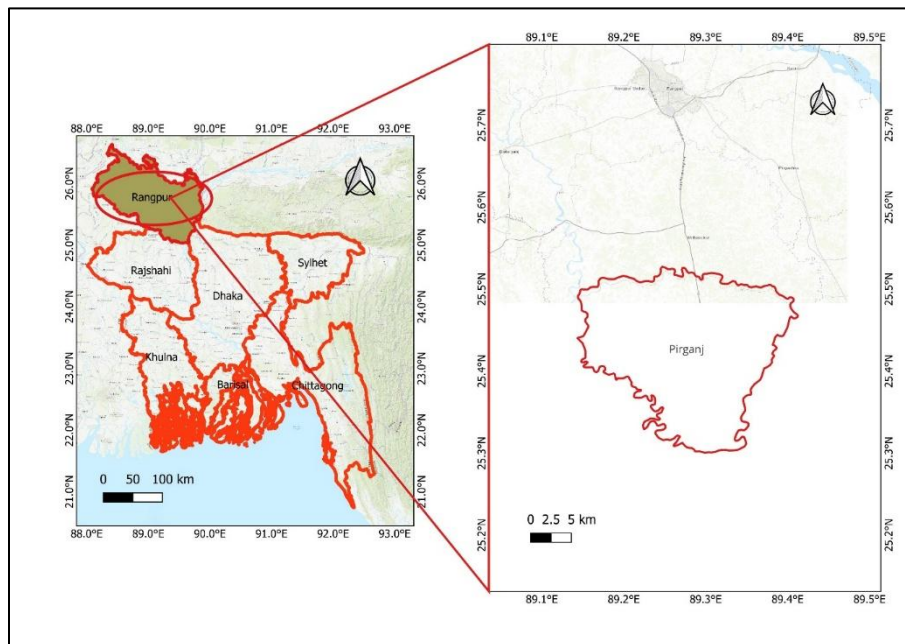


Figure 1. Map of the study area (Prepared by QGIS software).

Measurement techniques of the variables

The independent variables of this study, along with their statistical measurements, are presented in Table 1. The effectiveness of food-based training for school teachers was the dependent variable of the study. The respondents were asked to give their opinions on 25 selected food- and nutrition-related information items regarding their effectiveness. To measure the effectiveness scores of the selected three dimensions of

information, such as information received, understanding and application, were added. The first dimension included the involvement of the school teacher in receiving information; the second ensured understanding of the received information; and the third covered the application of the information to their daily food habits. Each of the dimensions was measured separately using a 4-point rating scale against the selected food- and nutrition-related information.

Table 1. Variables and their measurement for statistical analyses.

Independent variables	Data types	Measurement and units
Age	Continuous	No. of year
Professional experience	Continuous	No. of year
Educational qualification	Continuous	Year of schooling
Physical mobility	Continuous	Score
Training received	Continuous	No. of Day (s)
Knowledge on food and nutrition	Continuous	Score

Information received

Information received was calculated by computing information-received sub-scores (IRS) for each school teacher. The weights assigned to the scale were 0 for 'not at all', 1 for 'low', 2 for 'moderate', and 3 for 'high'. The IRS of a school teacher was obtained by adding the scores from selected food- and nutrition-related information. Thus, a respondent's IRS could range from 0 to 75, where 0 indicates non-receipt and 75 indicates high receipt of food- and nutrition-related information.

Understanding of the received information

It was assumed that understanding of the information may be less than the information received. The school teacher's understanding of the received information was calculated using information understanding sub-scores (IUS) for each school teacher. The weights assigned to the scale were 0 for 'not at all', 1 for 'low', 2 for 'moderate', and 3 for 'high'. The IUS of a school teacher was obtained by adding the scores for the selected 25 food- and nutrition-related items. Thus, a respondent's IUS could range from 0 to 75, where 0 indicates no understanding and 75 indicates a high level of understanding of the information received.

Application of received information

The third and last dimension of the dependent variable means, after understanding of food- and nutrition-related information, how much information they apply in their daily and familial lives. It was assumed that the application of information may be less than understanding of information. The application of information by the school teacher was calculated using information application sub-scores (IAS) for each teacher. The weights assigned to the scale were 0 for 'not at all', 1 for 'low', 2 for 'moderate', and 3 for 'high'. The IAS of a school teacher was obtained by adding the scores for selected food- and nutrition-related information. Thus, the IAS of a respondent could range from 0 to 75, where 0 indicates no application, and 75 indicates high application of the information received from training.

Preparation and administration of data collection tools

A data collection tool is a device used to collect data. The interview schedule was developed on various aspects of the objectives considered in the present study. An interview schedule was prepared to collect quantitative data. The validity and reliability of the data-gathering tools are ensured through proper statistical techniques. To ensure the validity of these instruments, the researcher constructed

questions that respondents would answer only to the research questions. The reliability test was computed using the internal consistency test by the Cronbach's coefficient Alpha. In this study, 0.785 was used to indicate the reliability of the interview schedule.

Statistical method employed for data analysis

Statistical analysis of quantitative data is an important aspect of research, as it facilitates the condensation and interpretation of collected data in a simple form, helps predict future trends, helps establish relationships between variables, and provides a sound basis for policy formulation. After data collection, the data was entered into SPSS 25.0 for data analysis. Then the normality of the data was tested, and any outliers were removed. Data was analyzed in the light of the objectives set forth for the proposed study. Various statistical techniques, such as frequency, percentage, mean, standard deviation, coefficient of correlation, and multiple regression, were used for data analysis.

Data Analysis

The collected data was analyzed using software such as SPSS version 25.0. The primary unit of analysis was the individual, with results summarized by study area.

RESULTS

Demographic Characteristics of the Respondents

Table 1 presents descriptive statistics for various characteristics of school teachers in the Rangpur district of Bangladesh (n=172). Below is a description of each characteristic as given in Table 2.

The teachers' ages range from 23 to 59 years, with an average (mean) age of 47.4 years and a standard deviation (SD) of 8.4 years, indicating moderate variability in age. Professional experience ranges from 5 to 40 years, with a mean of 17.5 years and an SD of 12.5 years, indicating a wide range and considerable variability in teaching experience among respondents. The minimum educational qualification is 15 years, and the maximum is 18 years (likely reflecting years of formal education). The mean qualification is 16.1 years (SD 1.1), suggesting that most teachers have similar educational backgrounds, possibly corresponding to college or graduate-level education.

Scores range from 0 to 19, with an average of 11.9 and a standard deviation of 3.7. This indicates variability in physical mobility among teachers, though further context would be needed to interpret these scores. Teachers have received between 3 and 33 training sessions (or units), with

an average of 10.2 sessions and an SD of 7.4, indicating a substantial range in the amount of professional training among respondents. Scores (possibly from an assessment)

range from 4 to 23, with an average of 13.4 and an SD of 4.1, reflecting moderate variability in teachers' knowledge of food and nutrition.

Table 2. Descriptive statistics of the selected characteristics of the respondents (n= 172)

Characteristics	Minimum	Maximum	Mean	SD
Age	23	59	47.4	8.4
Professional experience	5	40	17.5	12.5
Educational qualification	15	18	16.1	1.1
Physical mobility	0	19	11.9	3.7
Training received	3	33	10.2	7.4
Knowledge on food and nutrition	4	23	13.4	4.1

Data demonstrates diversity in age, professional experience, physical mobility, and training received, with more uniformity in educational qualifications. These statistics provide a comprehensive overview of the demographic and professional profile of school teachers in Rangpur district.

Age of respondents

The attached graph illustrates the age distribution of school teachers in the Rangpur district of Bangladesh based on survey responses. The respondents are grouped into three age categories:

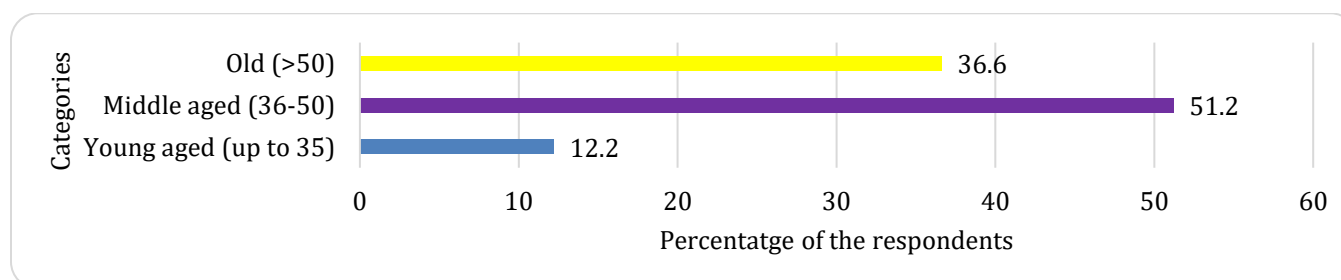


Figure 2. Distribution of the respondents based on their age.

51.2%, of teachers fall within the middle-age range, indicating that over half of the teaching workforce in this district is in their mid-career stage. Teachers >50 years were 36.6% indicating a significant presence of more experienced educators. The young group (<35 years) were 12.2%, indicating a relatively small proportion of younger teachers among the respondents.

Professional experience

Figure 3 shows 52.3% teachers have a moderate amount of professional experience. 18.0% of teachers have extensive experience, with over 29 years in the profession, while 29.7% of the respondents fall into this category, indicating that nearly a third of the teachers have relatively little experience.

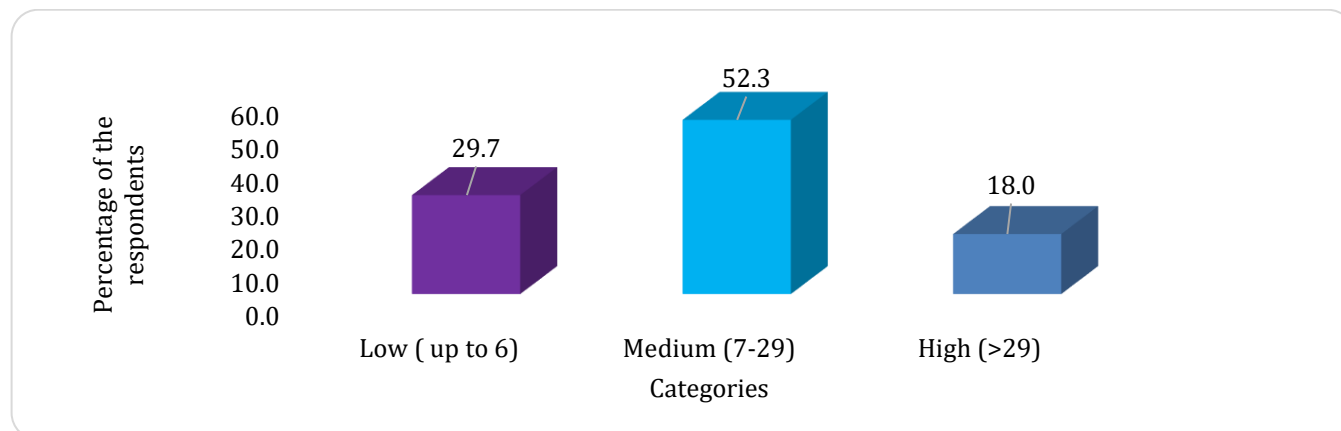


Figure 3. Distribution of the respondents based on their professional experience.

Educational qualification

Figure 4 presents the distribution of respondents in the Rangpur district of Bangladesh by educational qualification. The findings showed that a substantial majority (75.0%) hold a master's degree. 22.1% of respondents hold an honors (bachelor's) degree. Only 2.9% of the teachers have completed

education at the higher secondary level. In summary, the figure shows that the vast majority of school teachers in the study areas are highly qualified, with three in four holding a master's degree. This reflects positively on the professional standards and aspirations within the teaching community of the region.

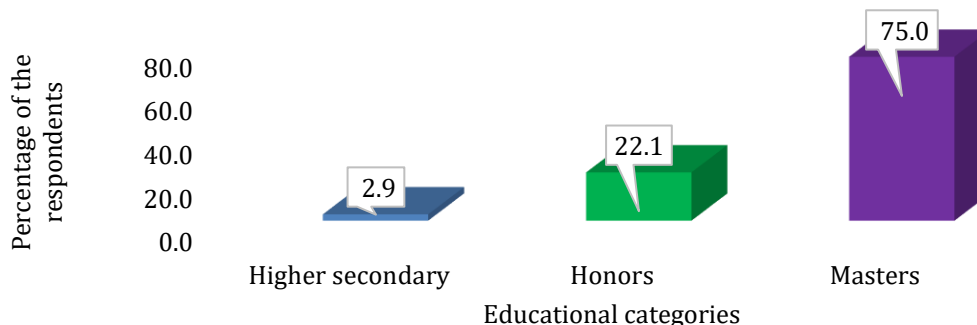


Figure 4. Distribution of the respondents based on their educational qualification.

Physical mobility

Figure 5 displays the distribution of respondents by physical mobility across four categories: no mobility (0), low mobility (1-9), medium mobility (10-15), and high mobility (>15). The largest portion of respondents (69.2%) fall into the "medium" physical mobility category, suggesting that most individuals can engage in typical physical activities without major limitations. 18.6% have "Low" mobility, indicating some

limitations that may restrict participation in more demanding physical activities. 11.0% are categorized as having "High" mobility, indicating they are likely highly active. A very small percentage, 1.2%, report having "No" physical mobility. In summary, the majority of respondents have moderate physical mobility, with smaller proportions having either low or high mobility, and only a small group reporting no mobility at all.

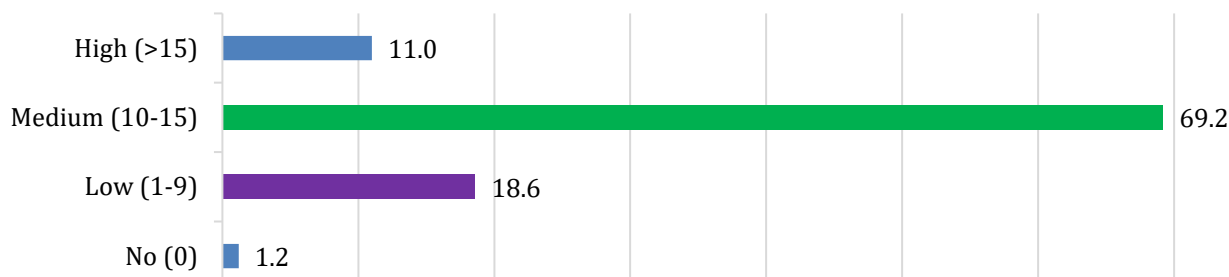


Figure 5. Distribution of the respondents based on their physical mobility.

Training received

Figure 6 depicts the distribution of respondents by the duration of training they have received. The respondents are categorized into three groups (low, medium, and high) according to the total number of days attended in training sessions. Medium received training is the largest group, comprising 62.2% of respondents. A

majority have received a moderate level of training. 24.4% of respondents fall within low group, indicating a smaller segment has received minimal training. High (>17 trainings): 13.4% belong to high training group, representing those who have participated in a high number of training sessions. Figure also shows that most respondents have received a moderate amount of

training, with fewer having either very low or very high levels of training exposure. This suggests a central

tendency toward moderate food-based training among the group surveyed.

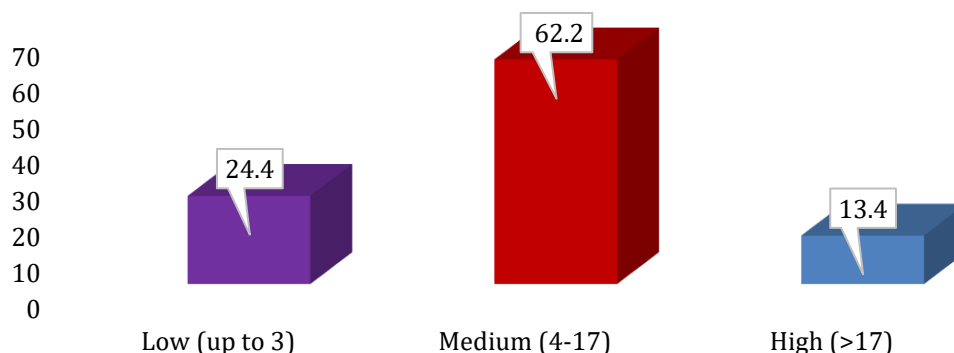


Figure 6. Distribution of the respondents based on their training received.

Knowledge on food and nutrition

Figure 7 displays a bar chart illustrating the distribution of respondents by their knowledge of food and nutrition. The respondents are grouped into three categories according to their knowledge scores. The findings revealed that 22.7% of respondents fell into the low category, indicating that about one-fifth had a limited understanding of food and nutrition. On contrast, the majority, 67.4%, are in the medium knowledge group.

This suggests that most respondents possess a moderate understanding of food and nutrition topics.

In contrast, only 9.9% of respondents demonstrate a high level of knowledge about food and nutrition. Overall, the Figure reveals that most respondents have a medium level of knowledge, with fewer individuals at either the low or high ends. This distribution highlights a central tendency toward moderate awareness about food and nutrition among the surveyed group.

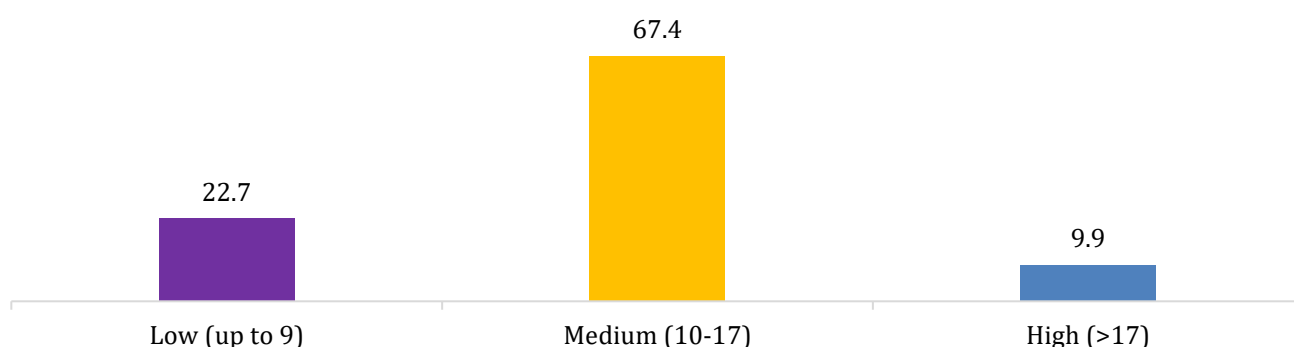


Figure 7. Distribution of the respondents based on their knowledge on food and nutrition.

Effectiveness of Training Received on Food and Nutrition

Dimension-wise effectiveness of training received on food and nutrition

Overall information receives

Figure 8 is a bar chart showing the distribution of respondents by their information-received scores. The data is divided into three categories: High (>50),

Medium (26–50), and Low (up to 25). The findings showed that most respondents fall into the 'High' information-receive category (71.5%), while far fewer are in the 'Medium' (15.7%) and 'Low' (12.8%) categories. This showcases that a large majority of the group assessed have received considerable information, whereas only a small portion has received low to medium levels of information.

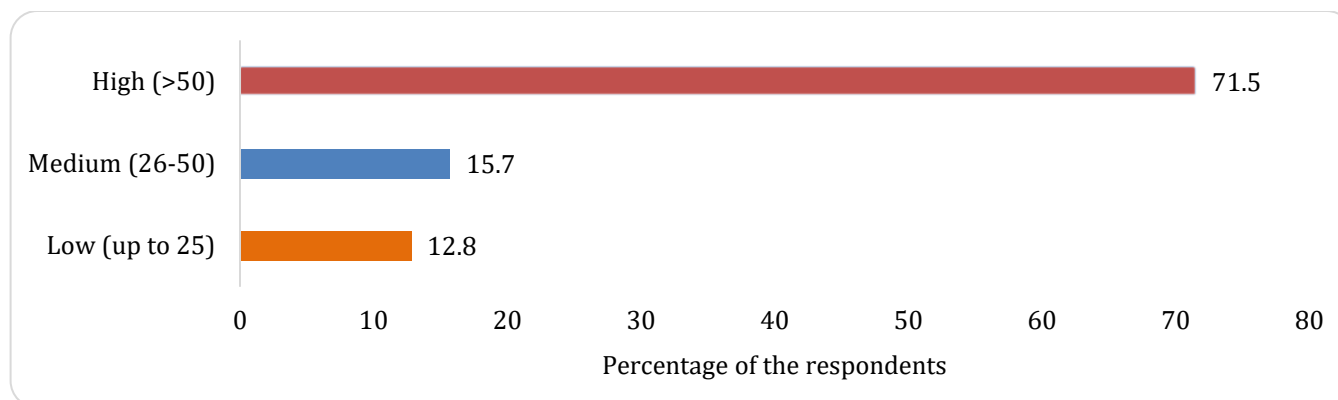


Figure 8. Distribution of the respondents according to their information receive scores.

Overall understanding of the received information

Figure 9 depicts the distribution of respondents by their level of understanding of the information they received. The respondents are divided into three categories based on their understanding scores. Medium is the largest group, with 58.7% of respondents. The majority of people had a moderate or average level of understanding. 26.7% of respondents fall into the low category, indicating a limited understanding of the information received. Only 14.5% of respondents are in

this group, representing those with a high level of understanding of the information. Overall, most respondents (nearly 60%) had a medium level of understanding, just over a quarter (about 27%) had a low level of understanding, and a much smaller fraction (about 15%) had a high level of understanding. This indicates that, for the majority, the received information was somewhat comprehended, but relatively few fully understood it, and a significant portion had difficulty understanding it well.

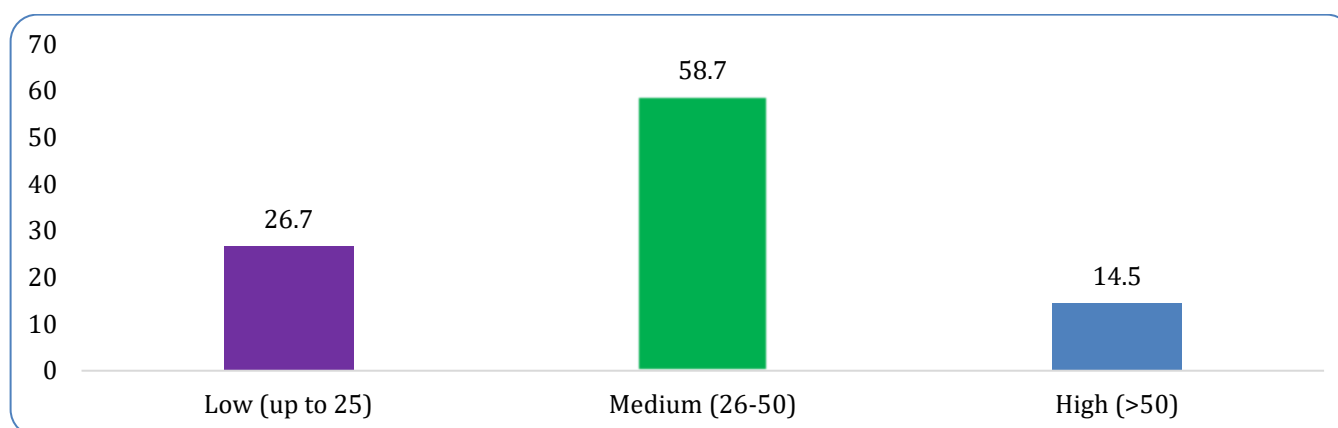


Figure 9. Distribution of the respondents according to understanding of the received information.

Overall application of received information

The Figure 10 displaying the distribution of respondents according to their application of the received information. The respondents are classified into three categories, each representing their level of application: The largest group, 42.4% of respondents, is in the medium category. This suggests that most respondents apply the information they receive at a moderate level. While 29.1% of respondents are in the high category, a similar proportion to the “low” group actually apply the

information they receive extensively. 28.5% of respondents fall into the low category, indicating that a little over a quarter applied the information they received at a low level. The majority of respondents are in the medium category for application of received information, followed closely by those in the high and low application groups. This distribution shows that while many people use the information they receive to a moderate extent, a considerable proportion also apply it to a high or low degree.

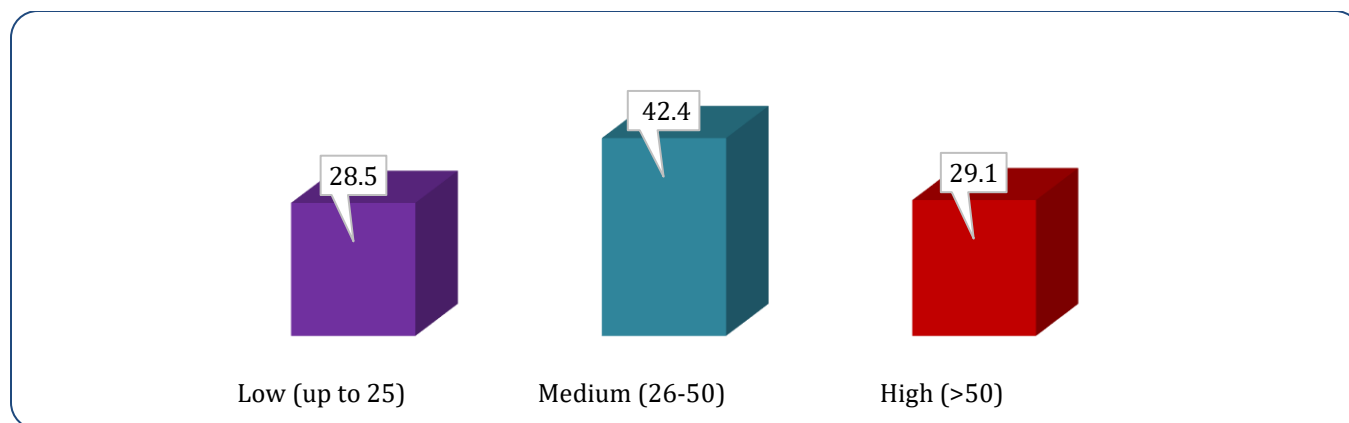


Figure 10. Distribution of the respondents according to application of the received information.

Overall effectiveness of training received on food and nutrition

Figure 11 shows the distribution of school teachers according to their overall effectiveness in food-based training. The effectiveness levels are categorized as follows: 'Low (up to 75)', 'Medium (76-150)' and 'High (>150)'. The majority (over 60%) of school teachers in Rangpur district experience a moderate (medium) level of effectiveness from food-based training. This means most gained some positive outcomes, but there is room

for improvement. Fewer than one-fifth (17.4%) achieved high effectiveness, suggesting that only a small segment could fully utilize or benefit from the training programs, or that the programs could be further tailored to improve outcomes. About 1 in 5 teachers (22.1%) are in the low-effectiveness group, suggesting that current training strategies may not reach or satisfy all participants equally and highlighting the need for further support or revised approaches for these teachers.

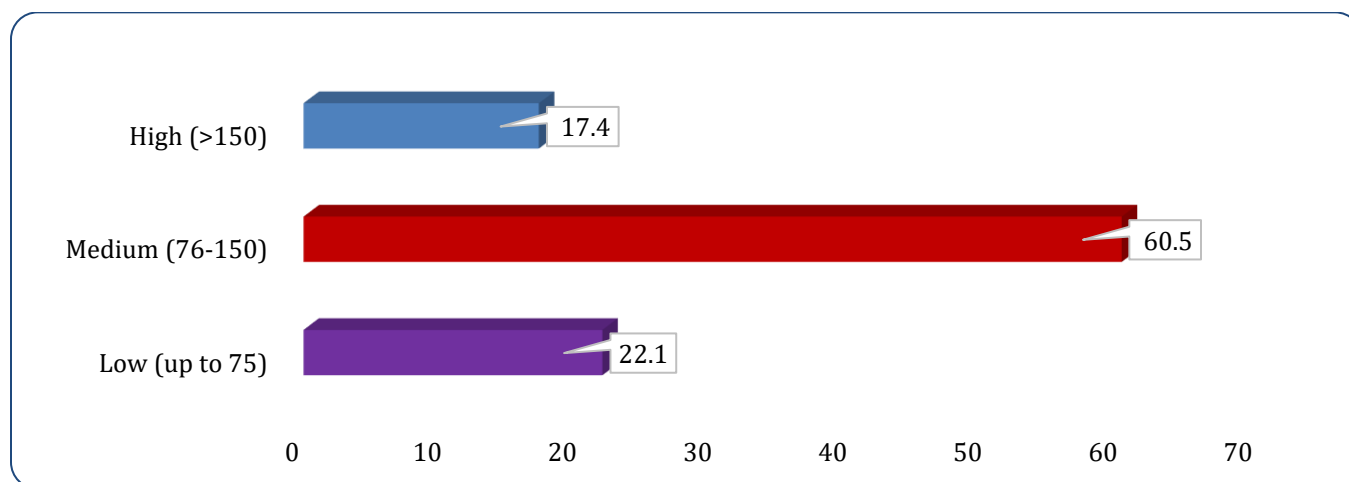


Figure 11. Distribution of the respondents according to overall effectiveness.

Relationships between the Selected Characteristics of the Farmers and Effectiveness

The Table 3 presents the statistical relationships between selected characteristics (independent variables) of school teachers and the effectiveness of food-based training (dependent variable) in the Rangpur district of Bangladesh. The relationships are expressed as correlation coefficients ("r").

According to the computed correlation coefficients (r) among the six selected characteristics of the respondents' age, educational qualification, physical mobility, training received, and knowledge on food and nutrition, they showed a positive significant relationship with the effectiveness of food-based training;. At the same time, their professional experience had no significant relationship.

Table 3. Relationships between the dependent and independent variables.

Dependent variable	Independent variables	Computed values of 'r' with 170 d.f.
Effectiveness of food-based training	Age	-0.208**
	Professional experience	0.017 ^{ns}
	Educational qualification	0.381**
	Physical mobility	0.507**
	Training received	0.352**
	Knowledge on food and nutrition	0.377**

**, significant at 1 percent level of significance

Multiple Regression Models with Significant Independent Variables on the Extent of Effectiveness of BIRTAN Food-Based Training

The coefficient of correlation indicates the linear relationships between the two variables. It does not say anything about the contribution of a particular independent variable to the dependent variable. Therefore, a linear multiple regression analysis was conducted to determine the contribution of various

characteristics of secondary teachers to the effectiveness of BIRTAN food-based training. Only those variables that had a significant relationship with effectiveness were included in the regression model. Thus, a total of six variables, namely age, professional experience, educational qualification, physical mobility, training received, and general knowledge of food and nutrition, were used in the model, as they were related to the effectiveness of food-based training (Table 4).

Table 4. Multiple regression analysis of independent variables of school teachers with effectiveness of food-based training.

Independent variables	Regression Coefficients		t	Significant level
	Unstandardized coefficient	Standardized coefficient (β)		
(Constant)	120.091		11.527	.000
Age	-0.169	-.133	-2.074	.040
Professional experience	-0.018	-.021	-.318	.751
Educational qualification	2.293	.232	3.734	.000
Physical mobility	1.014	.347	5.044	.000
Training received	0.184	.127	1.937	.054
General knowledge on food and nutrition	0.550	.210	3.346	.001

n= 172, df= 171, R= 0.645, R² = 0.416, F= 19.55, **P<0.01, *P<0.05

The regression coefficient for five variables, namely age, educational qualification, physical mobility, training received, and general knowledge of food and nutrition, was statistically significant, indicating that these variables made a significant contribution to the effectiveness of BIRTAN food-based training. The other variable, namely professional experience, had no significant contribution to the same. The R² value was 0.416, and the corresponding F value was 19.55, both significant at the 1% level. The R² value indicated that 41.6 percent of the total variation in the effectiveness of BIRTAN food-based training was explained by the six variables included in the multiple regression analysis. In summary, educational qualification, physical mobility, and general knowledge on food and nutrition are strong positive predictors of effectiveness in food-based

training among school teachers. At the same time, age has a slight negative effect. Professional experience does not significantly affect effectiveness in this model. Training received shows a positive trend but is marginally significant. The model explains a substantial portion of the variation in effectiveness.

DISCUSSION

The findings indicate that the majority of secondary school teachers (51.2%) were in the middle-age category, suggesting that more than half of the respondents were in mid-career. This age group is considered highly relevant for evaluating the effectiveness of BIRTAN food-based training because teachers at this stage generally possess adequate teaching experience, professional maturity, and

openness to adopting improved teaching approaches. Their longer exposure to classroom practices enables them to effectively understand, interpret, and disseminate nutrition and food-related knowledge gained from the training among secondary school students. Day and Gu (2007) highlighted that mid-career teachers often possess a strong professional identity, accumulated classroom knowledge, and the capacity to contribute to educational improvement. They also noted that experienced teachers continue to develop professionally when training opportunities are relevant to their practice. Teachers with moderate experience may be better positioned to integrate food-based training content into their existing teaching practices, as they already possess basic pedagogical and classroom management skills. In the context of BIRTAN training, such teachers can serve as effective agents in transferring nutrition-related knowledge, healthy food practices, and dietary awareness to secondary school students. This interpretation is supported by research showing that professional development is more effective when teachers can connect new knowledge with their existing classroom experiences. Garet et al. (2001) reported that effective teacher training depends on active learning and linking professional development activities with teachers' classroom practices. Similarly, Popova et al. (2018) emphasized that teacher training becomes more effective when it develops teachers' practical experience and content-specific knowledge.

The finding indicates a relatively high level of educational attainment among participating teachers. Higher academic qualifications may enhance teachers' ability to understand scientific concepts related to food, nutrition, health, and dietary practices included in BIRTAN training. Teachers with postgraduate education are generally expected to have stronger information-processing ability, analytical skills, and motivation for continuous professional development. Therefore, the high proportion of master's degree holders may have contributed to the effectiveness of BIRTAN food-based training by enabling teachers to comprehend the training materials better and communicate nutrition messages to students more effectively. The finding suggests that most teachers had a moderate level of ability to participate in training activities. Since effective professional development often requires active participation, collaboration, and practical learning activities, ensuring accessibility can improve the impact

of nutrition training programs. The finding indicates that most teachers had some experience with professional training but were not highly exposed to repeated training programs. This finding is particularly relevant to the effectiveness of BIRTAN food-based training. Teachers with moderate previous training exposure may have sufficient familiarity with professional learning environments while still having opportunities to acquire new knowledge and skills. The BIRTAN training may therefore help fill existing knowledge gaps in food safety, nutrition, balanced diets, and food-based approaches.

Previous studies indicate that teacher professional development improves teaching practices when training is relevant, content-focused, and connected to teachers' needs. Nutrition education research also identifies teacher training as a key strategy for improving the delivery of school-based nutrition education (Dunn et al. 2019).

The finding suggests that most teachers possessed a basic understanding of food and nutrition concepts but may have had gaps in advanced knowledge before or after training. This result underscores the importance of BIRTAN food-based training, as its purpose is not only to provide information but also to improve teachers' capacity to promote evidence-based food choices and nutrition practices among students. Teachers with moderate baseline knowledge may show considerable improvement after training because they have a foundational understanding and still have room for further knowledge enhancement. Nutrition education studies indicate that teachers require adequate knowledge and confidence to deliver nutrition messages in schools effectively. Professional development programs focusing on nutrition content and teaching strategies can improve teachers' ability to implement nutrition education activities (Peralta et al. 2020).

The finding indicates that the food-based training program conducted by the Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN) generated a measurable but intermediate level of effectiveness among secondary school teachers at Pirgonj Upazila, Rangpur District. This suggests that the training was successful in improving teachers' understanding, awareness, and application of food- and nutrition-related concepts; however, the magnitude of improvement was insufficient to achieve a high level of effectiveness for most participants. BIRTAN is a government organization working on applied nutrition

research, training, and nutrition awareness activities in Bangladesh. Several factors may explain the moderate effectiveness level. First, teachers serve as an important link between nutrition knowledge and adolescent students by integrating food-based concepts into classroom teaching and influencing students' dietary awareness. Previous research has shown that school-based nutrition education programs can improve nutrition knowledge, attitudes, and dietary practices when teachers receive appropriate training and educational resources (Nyma et al. 2023). Therefore, participation in BIRTAN training likely enhanced teachers' knowledge of balanced diets, food groups, the importance of micronutrients, food safety, and healthy eating practices. However, achieving only a moderate level of effectiveness may reflect limitations in training duration, follow-up support, teaching resources, and opportunities for practical application. Knowledge gained through short-term training does not always translate immediately into sustained behavioural change or classroom implementation. According to nutrition education frameworks, effective programs require not only knowledge transfer but also repeated reinforcement, supportive environments, practical demonstrations, and behaviour-oriented approaches (Contento, 2016). Thus, teachers may have acquired basic competencies yet still face challenges in applying food-based education effectively in their regular teaching activities. FAO (2020) emphasized that school-based food and nutrition education programs in low- and middle-income countries require trained teachers, appropriate educational materials, and institutional support to achieve sustainable outcomes. This supports the moderate effectiveness observed among trained teachers, as training is an essential but not sufficient component of successful nutrition education.

From the multiple regression analysis, the significant contribution of age suggests that teachers' maturity and life experience may influence their ability to understand, interpret, and apply food and nutrition knowledge gained through BIRTAN training. Older teachers may possess greater practical experience regarding community health issues, student behaviour, and local dietary practices, enabling them to connect training content with real-life situations. Similar findings have been reported in nutrition education studies, in which demographic factors, including age, influenced teachers' nutrition knowledge and educational outcomes. Habib et

al. (2023). Teachers with higher academic backgrounds may have greater capacity to understand scientific nutrition concepts and integrate them into classroom teaching. Higher educational attainment may improve information-processing ability, critical thinking, and the utilization of training materials. Teachers who have greater mobility and exposure outside their immediate working environment may achieve higher effectiveness from food-based training. Physical mobility may reflect participation in professional activities, access to information sources, interaction with different communities, and exposure to diverse food and nutrition practices. Professional training programs are effective mechanisms for improving teachers' nutrition competencies. BIRTAN, as a national applied nutrition training institute, aims to enhance nutrition awareness and capacity through research and training activities. Previous intervention studies have demonstrated that participatory nutrition training improves participants' nutrition knowledge and dietary awareness. Davidson et al. (2025) reported that participatory nutrition training interventions in rural Bangladesh improved nutrition knowledge and dietary outcomes, although improvements in knowledge alone may not always translate into behavioural change without supportive conditions. Teachers who already possessed better baseline knowledge were more likely to benefit from BIRTAN training. Existing knowledge creates a foundation for acquiring advanced concepts and applying new information effectively.

CONCLUSION

While the majority of school teachers benefit moderately from the food-based training programs, indicating a generally positive impact, there remains significant potential to enhance its effectiveness. Based on the computed correlation coefficients, it can be concluded that several key characteristics of school teachers, namely age, educational qualification, physical mobility, training received, and knowledge on food and nutrition, have a significant positive relationship with the effectiveness of food-based training. This indicates that teachers with higher education levels, better physical mobility, more prior training, and greater knowledge in food and nutrition tend to benefit more from the training programs. There is room for improvement in the effectiveness of food-based training programs, so the concerned authority, BIRTAN, might implement

appropriate programs in this regard. Based on the findings of the correlation coefficient, it is recommended that these characteristics be emphasized in the planning and execution of a food-based training program.

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