



# Celebrating 50 years of Independence of Bangladesh

**SPECIAL ISSUE  
PUBLICATION**



# **Special Issue** **Section - II**

## **Research on Health Science Topics**

## Commemorating 50<sup>th</sup> year of Independence of Bangladesh - Scholarly Research Investigations

With utmost respect from the core of our hearts, we intend to commemorate the 50th year of Independence of the Great Nation of the People's Republic of Bangladesh by acknowledging the ground-breaking research calibre of the Bangladeshi Research Scientists and Scholars, who kept on delivering with outstandingly innovative experimentations throughout the world. We conceived this special issue to provide a platform to disseminate outcomes of multidimensional research investigations, which have been conducted mostly in universities and research institutes in Bangladesh and neighbouring nations. These highly skilled research scientists of Bangladesh have employed cutting-edge technologies to investigate the complex and yet unexplored aspects associated with diverse areas of life ranging from medical and health issues, cognitive neuroscience, rehabilitation sciences, issues pertaining to motor control, enhancement in sports performance, motor skill limitations influencing overall development among Specially Able Children and factors associated with management of health risk as well.

In this Special issue in Section I, we have included the meta-analytic systematic review studies. These studies have examined impacts of lifestyle on PCO; effectiveness of proprioceptive training on OA limitations; efficacy of differential coordination training regimes on motor deficiencies; and benefits of VMBR and Biofeedback techniques on the performance of athletic skills. Here, the noteworthy fact is that all those meta-analytic investigations have been conducted including almost every of the previously carried out valid and authentic RCTs following rigorous methodology.

Health Science topics in Section - II have encompassed extensive research on exclusively vital current issues associated with the awareness and behavioural manifestations pertaining to the outbreak of COVID19 from a Bangladeshi perspective. Further to that, studies on the impacts of exercise interventions in enhancing health status as well as cognitive functions as the precursor for effective management of Type 2 DM among Bangladeshi individuals and cost-effectiveness of those interventions, are breakthrough investigations that are already universally acknowledged as apex research outcomes. Section III, however, has included studies on cognitive neuroscience aspects associated with neural processing of auditory attention characteristics in dyslexic children, and visual attention and language processing investigated among pregnant women. These studies have been carried out incorporating sophisticated gazettes for the assessment of topographic cortical activation based on ERP and fMRI evaluations. In this section experiments on the rehabilitation sciences are also disseminated. While one case study has reported on the utilization of unique techniques for prosthetic rehabilitation, the other study has been conducted introducing EMG biofeedback and modified isokinetic intervention techniques following rigorous methodology to minimize feelings of pain and perceived stiffness among elderly osteoarthritic patients. Finally, Section - IV has been considered to include investigations on the effectiveness of VMBR and Biofeedback intervention techniques on athletic performance excellence; the impact of motor skill training on complex reaction ability in young-adult individuals having partial dyspraxia. Apart from all those, this section has also included outcomes of an extensive study on Specially Able Children, in which facilitative impact of young athlete (motor skill-oriented) training on tandem walking ability has been thoroughly investigated.

We have critically reviewed (double-blind review) and evaluated all the manuscripts submitted for publication in this issue. The final reviewer has adequately ensured that as per the suggestions of the reviewers, original research submissions have been optimally modified. Thereafter, all the Section Guest-editors of this issue, upholding the core academic and research integrity, have endeavoured to leave no stone unturned to warrant the quality and validity of the research documents accepted for publication. In every section content of the articles are linked with the cited references, which may provide optimal opportunity to the learned researchers. Apart from that, we have also provided back-and-forth links of cited documents, so that the readers can easily check the citations in the list of references and can promptly go back to the area of discussion.


We can vouchsafe that we have aspired only to invigorate the academic and research milieu of Bangladesh. This country on the brink of achieving hard-earned independence was proclaimed as the “bottomless basket”. I am sure I am not the only one who strives hard to showcase the development of the Nation of Bangladesh, the country having full of enthusiasm. Here I am being the Lead Guest-Editor would like to acknowledge the dedication of all the Guest -Editors and Reviewers for their sincere contributions. I would most sincerely like to thank all of them, who relentlessly took care of their responsibilities to ensure the validity of the research articles and the high academic standard of this issue.

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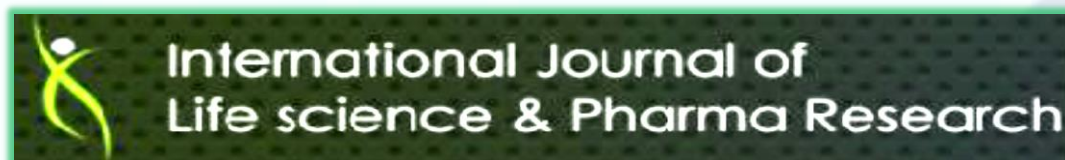
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# EFFECTS OF EXERCISE INTERVENTIONS ON IMPROVEMENT IN COGNITIVE FUNCTIONALITY OF BANGLADESHI DIABETIC INDIVIDUALS

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## KEYWORDS:

Type 2 Diabetes Mellitus, Aerobic exercise,  
Combined exercise, Cognitive Functionality,  
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## ABSTRACT

**Background:** T2DM individuals are mostly evident as vulnerable to cognitive dysfunction, which perhaps lead to cognitive impairment associated with visual motor disorientation.

**Aim:** This study aims to assess the impacts of aerobic and combined exercises in cognitive functionality of the T2DM participants in Dhaka, Bangladesh.

**Method:** 66 middle-aged T2DM individuals residing in Dhaka, Bangladesh was included in the study. In this research Bender-Gestalt II test was used for the evaluation of comprehension and working memory status of T2DM population. There was 14 weeks of intervention sessions along with another 14 weeks of no intervention session to evaluate the sustainability of the intervention programs carried out with a control and two differential exercise intervention groups. Two-way repeated measure of ANOVA was used to analyse the data.

**Results:** There were statistically significant differences observed in pre-to post intervention phase ( $p = .000$ ) and pre-to follow up phase ( $p = .000$ ) in participants with negative mean differences relating to higher value in post and follow up phase respectively in comprehension and working memory score of visual motor abilities in both aerobic and combined exercise intervention programs.

**Conclusions:** It can be concluded that participants in the aerobic and combined exercise intervention have shown improvement in overall improvement in comprehension and working memory status of T2DM individuals in Dhaka, Bangladesh. However, no group wise difference was evident among the participants.

## 1. INTRODUCTION

Diabetes has been considered as one of the most common metabolic disorders all over the world<sup>1</sup>. The existing literature has demonstrated that diabetes imposes a large and ever-increasing burden on people. Moreover, with the rapid pace of urbanization, drastic changes in lifestyles have triggered the chances of increasing the risk factors for non-communicable diseases such as Type 2 diabetes mellitus (T2DM)<sup>1</sup>. This changing phenomenon has been observed throughout the world but especially in the developing countries where the impact of diabetes falls both on individuals and their families to the entire communities and nations<sup>2</sup>. Diabetes-related misery – emotional distress linked to the problems of living with diabetes and its management – is quite common among adults with T2DM<sup>3</sup>. Diabetes suffering includes burdens of the rigorous self-management routine, emotional suffering, uncertainties about glycemic control, and frustration over not receiving adequate support from close ones and providers for handling diabetes<sup>4</sup>.

The occurrence of depression is considerably higher among people with type 2 diabetes than among those without diabetes, and that prevalence among females with diabetes is higher than among males<sup>5</sup>.

There is both cross-sectional<sup>6</sup> and longitudinal evidence that depression is associated with poor glycemic control. A systematic review also found evidence of the association of depression with treatment non-adherence<sup>7</sup> while another found an association with poor dietary control<sup>8</sup>. There is also evidence of the association of depression with less physical activity and diabetes self-care activities<sup>9</sup>. A meta-analysis found comorbid depression to be associated with greater diabetes complications, including diabetic retinopathy, nephropathy, neuropathy, microvascular complications, and sexual dysfunction<sup>10</sup>. Evidence also exists of an association of depression with coronary heart disease in women<sup>11</sup>. In addition, comorbid depression is associated with a higher risk of disability and decreased work productivity as well as a significant deterioration in quality of life<sup>12</sup>.



Comorbid depression is also associated with increased health services utilization and costs especially inpatient care, ambulatory visits, and prescriptions<sup>13</sup>. Finally, comorbid depression has been found to be associated with all-cause mortality among Medicare beneficiaries<sup>14</sup> and in the general US population.

T2DM individuals are mostly evident as vulnerable to cognitive dysfunction, which perhaps lead to cognitive impairment associated with visual motor disorientation<sup>15,16</sup>. Alosco et al.<sup>17</sup> in their work opined that minimal deficiency in mobility is associated with worse cognitive function in T2DM individuals. It has been suggested that, probably Asian, particularly, South-Asian T2DM individuals may have progressive cognitive decline<sup>18</sup>. Probably, that was also a reason behind observed relatively higher incidences of depression and negative mood prevalent amongst T2DM individuals. It is being pointed out, since the existing evidence suggests that prefrontal regions may act as neural correlates associated with depression and cognitive dysfunction and the resultant onset of T2DM<sup>19,20</sup>.

Aerobic exercise has been proposed as effective in improving working memory score of the T2DM participants, if they are not having brain damage<sup>21</sup>. Perhaps, T2DM individuals pass through stages of neuronal changes in specific brain regions such as the hippocampus and prefrontal cortex, which explained reasons behind cognitive deficits<sup>22,23</sup>. In patients with T2DM, the functional connectivity between the hippocampus and other brain regions gets reduced<sup>24,25</sup> which results in decline in cognitive performance in T2DM, which is associated with a reduction in functional connectivity<sup>24</sup>. T2DM individuals if do not face problems of any memory failure, they may not have any cognitive deterioration<sup>21</sup>. In these cases, as Cipolotti, & Warrington<sup>21</sup> postulated, these T2DM individuals could engage in elaborative encoding, and could develop their own encoding strategy, in order to enhance in their level of working memory<sup>22,23</sup>. Combined introduction of exercise training regime may lead to higher-order cognitive competence, in the form of enhancement in visual motor integration and configurational ability<sup>21</sup>.

There were few research studies done on the assessment of comprehension skill and working memory skills associated with visual motor abilities aspect of the type 2 diabetic population. As a result, it gives a scope to carry out investigation on these psychological features of T2DM population to understand the cognitive functionality of the T2DM population in Dhaka, Bangladesh.

## 2. METHODOLOGY

### 2.1 Participants

In this study, 75 participants were selected from 123 participants on the basis of pre-determined inclusion and exclusion criteria (Refer to Sultana, 2018 for complete list of inclusion and exclusion criteria)<sup>26</sup>. All the participants were residing in Dhaka, Bangladesh and invited from the outpatient department (OPD) of the Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorder (BIRDEM) General Hospital. The ethical approval was obtained from the Bangladesh Institute of Sports Science (Ref.no.BISS/ACEC/0104) for this interventional study. All the 75 participants were divided into three groups. Group A was Control group (received no intervention), Group B was Experimental Group I (received aerobic exercise training i.e. walking) and Group C was Experimental Group II (received combined exercise, i.e. aerobic exercise training and resistance/strengthening exercise training).

Concealed allocation was followed for the experimental groups. In the study participants, researchers and trainers were all blinded for the study. Participants had complete freedom to withdraw from this study at any point of time at any inconvenience. Finally, 66 participants remained till the completion of the study.

### 2.2 Assessment Protocol & Intervention Technique

Bender® Visual-Motor Gestalt Test, Second Edition (Bender-Gestalt II)<sup>27</sup> was used to assess the visual-motor integration skills (comprehension and working memory skills) of the T2DM participants in Dhaka, Bangladesh. This test comprises of 16 stimulus cards and an observational form. Stimulus card numbers 1 to 13 were used for participants aged between 4 years to 7 years and 11 months and stimulus card number 5 to 16 were used for assessing participants aged between 8 years and older. In addition to that there were two supplemental tests, namely, perception test and motor test. In these tests, higher scores refer to better performance of the participants. There is a standardized scoring guideline for judging the drawing of the participants<sup>27</sup>. In this study, two different exercise interventions (aerobic and combined training) were practiced for two different intervention groups following a standardized protocol. The detailed information regarding the intervention technique can be found in Sultana et al., 2018<sup>26</sup>.

### 2.3 Data Analysis

Statistical Package for the Social Sciences (SPSS) version 23.0 was used for analyzing the data. Two-way repeated measure of ANOVA was used to examine the collected data. The significance level for all the analysis was set at  $p < 0.05$ . Normality and homogeneity of variance of the data were analyzed before the main analysis. Assumption of normality was carried out by using Shapiro-Wilk test ( $p > 0.05$ ) and assessment for homogeneity of variance was carried out by Mauchly's Test of Sphericity ( $p > 0.05$ ).

## 3. RESULTS

At the end of data collection, after drop outs, data of 66 participants were collected. Out of these participants, 21 males (31.8%) and 45 females (68.2%) were there with a mean age range of 55 years ( $54.90 \pm 4.18$ ). The mean BMI was 27.35 (kg/m<sup>2</sup>) for these participants. The average duration of T2DM in the participants was 8 years ( $8.00 \pm 1.16$ ) with mean HbA1c level of 9.85 (mmol/l) (Table 1).

**Table 1**  
**Socio-Demographic data of the participants**

Variables	Overall N=66	Control (No Exercise) Group n=22	Aerobic Exercise Group n=24	Combined Exercise Group n=20
	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD
Age (Years)	54.90 $\pm$ 4.18	53.15 $\pm$ 4.90	54.75 $\pm$ 3.31	56.80 $\pm$ 3.49
Gender				
Male	21 (31.8)	5 (22.7)	8 (35.3)	8 (40)
Female	45 (68.2)	17 (77.3)	16 (66.7)	12 (60)
BMI (kg/m <sup>2</sup> )	27.35 $\pm$ 4.69	29.80 $\pm$ 4.08	26.16 $\pm$ 4.57	26.09 $\pm$ 4.61
Underweight	0 (0)	0 (0)	0 (0)	0 (0)
Normal	22 (33.3)	4 (18.2)	9 (37.5)	9 (45)
Overweight	23 (34.8)	9 (40.9)	7 (29.2)	7 (35)
Obese	21 (31.8)	9 (40.9)	8 (33.3)	4 (20)
Diabetic year (Years)	8.00 $\pm$ 1.16	8.10 $\pm$ 1.25	7.80 $\pm$ 1.06	8.10 $\pm$ 1.21
HbA1c (mmol/l)	9.85 $\pm$ 1.64	9.95 $\pm$ 1.73	9.84 $\pm$ 1.54	9.76 $\pm$ 1.73

Table 2

*Comparison of Comprehension score of Visual Motor Abilities (Bender-Gestalt II) within each group based on phases (Time effect)*

Comparison	Control Group		Aerobic Group		Combined Group	
	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value
Pre - Post	-2.50 (-3.69, -1.30)	0.082	-1.70 (-2.63, -0.76)	0.000**	-1.80 (-2.75, -.875)	0.000**
Pre-Follow up	-2.45 (-3.31, -1.58)	0.053	-1.80 (-2.40, -1.21)	0.000**	-1.95 (-2.50, -1.39)	0.000**
Post – Follow up	0.05 (-0.56, 0.66)	1.00	-0.10 (-0.60, 0.40)	1.00	0.19 (-0.66, 0.36)	1.00

\*\* $p < 0.001$ ; Two - way Repeated measure of ANOVA within group analysis were applied followed by pairwise comparisons with 95% confidence interval adjusted by Bonferroni correction; MD = Mean Difference; CI = Confidence Interval

Table 3

*Comparison of Working Memory score of Visual Motor Abilities (Bender-Gestalt II) within each group based on phases (Time effect)*

Comparison	Control Group		Aerobic Group		Combined Group	
	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value
Pre - Post	-2.35 (-2.93, -1.77)	0.099	-2.60 (-3.34, -1.85)	0.000**	-2.35 (-3.04, -1.65)	0.000**
Pre-Follow up	-2.55 (-3.03, -2.06)	0.236	-2.95 (-3.59, -2.30)	0.000**	-2.60 (-3.18, -2.01)	0.000**
Post – Follow up	-0.20 (-0.69, 0.28)	0.890	-0.35 (-0.83, 0.12)	0.208	-0.25 (-0.67, 0.17)	0.405

\*\* $p < 0.001$ ; Two - way Repeated measure of ANOVA within group analysis were applied followed by pairwise comparisons with 95% confidence interval adjusted by Bonferroni correction; MD = Mean Difference; CI = Confidence Interval

In the aerobic group, there were statistically significant differences observed in pre-to post intervention phase and pre-to follow up phase in Bangladeshi participants with negative mean differences relating to higher value in post and follow up phase respectively in Comprehension score of Visual Motor Abilities (Table 2). In the combined exercise group, there were also statistically significant differences observed in pre-to post intervention phase and pre-to follow up phase in participants with negative mean differences relating to higher value in post and follow up phase respectively in Comprehension score of Visual Motor Abilities. Thus, it can be seen that at the post intervention phase there was the highest value of Comprehension score indicating better visual motor skills in Bangladeshi participants within all groups. (Table 2).

There were statistically significant differences observed in pre-to post intervention phase and pre-to follow up phase in participants with negative mean differences relating to higher value in post and follow up phase respectively in working memory score of Visual Motor Abilities (Table 3). Similarly, in the combined exercise group also, there were also statistically significant differences observed in pre-to post intervention phase and pre-to follow up phase with negative mean differences relating to higher value in post and follow up phase respectively in working memory score of Visual Motor Abilities. Thus, it can be seen that at the follow up phase there was the highest working memory score of Visual Motor Abilities indicating higher depth of processing memory skill within all groups. (Table 3).

#### 4. DISCUSSION

The aim of the study is to assess the impacts of aerobic and combined exercises in cognitive functionality of the T2DM participants in Dhaka, Bangladesh. In this research Bender-Gestalt II test was employed to evaluate the influences of differential exercise interventions across various phases and groups to find out probable significant improvements in comprehension and working memory skills of the participants.

A developing body of literature has distinguished diabetes distress from clinical depression, signifying that diabetes distress is more closely linked to worse illness management and treatment consequences<sup>28,29,30</sup> and supporting the development of capable interventions for diabetes distress<sup>31</sup>. This experimental evidence is accompanied by in-depth qualitative studies in diabetes mellitus that reliably suggest that clinical depression is too slender of a concept to incorporate the diverse emotional involvements described by distressed T2DM patients<sup>32</sup>. Metabolic Syndrome though have genetic contribution, is frequently influenced by diet and life stress. As glucose levels in the blood upsurge, the pancreas tries to overcompensate and yield even more insulin, which eventually leads to the characteristic symptoms of metabolic syndrome and simultaneously along with spike in insulin levels, a stress response occurs that leads to elevations in cortisol<sup>33</sup>, which in turn generates an inflammatory reaction, that if left unchecked begins to damage healthy tissue<sup>34</sup>. The occurrence of mood changes such as depression is considerably higher among people with type 2 diabetes than among those without diabetes<sup>5</sup>. Meanwhile, for decades, different types of exercises have been recommended along with diet and medication for the T2DM individuals to control their level of diabetes.

The results of this study showed that aerobic and combined exercise group of T2DM participants, post-intervention phase of assessment revealed phase wise improvement in both comprehension and memory score of visual motor abilities. Findings of beneficial impact of training on cognitive comprehension score, revealed higher-order cognitive competence, in the form of visual-motor integration and configurational ability<sup>21</sup>, which was evident among the participants. Addition to that T2DM individuals in the aerobic and combined exercise groups did not have any memory failure, and hence they did not have any cognitive deterioration<sup>21</sup>. In these cases, these T2DM individuals could engage in elaborative encoding, and could develop their own encoding strategy, to enhance in their level of working memory<sup>22,23</sup>.



This outcome revealed that in case of working memory, both the intervention techniques were effective in improving visual motor abilities. Combined and aerobic intervention training were observed as better compared to the control condition, which was also evident in the mean differences of the phasewise interaction effects. In this experiment, aerobic exercise participants were carrying out the stretching exercises along with regular walking and combined exercise participants were required to engage in both aerobic as well as resistance training, which perhaps improved level of mobility<sup>17</sup> and visual-motor engagement and integration<sup>21</sup> in those T2DM individuals. Thus, for this T2DM individuals considerably efficient mobility<sup>17</sup>, might have reduced visual motor disorientation<sup>15,16</sup>, and in consequence enhanced visual-motor integration was evident for both the intervention techniques. However, no group wise difference has been reported in this research to attribute the improvement to any specific exercise intervention program.

## 5. CONCLUSIONS & RECOMMENDATIONS

It can be concluded that participants in the aerobic and combined exercise intervention have shown improvement in overall improvement in comprehension and working memory status of T2DM individuals in Dhaka, Bangladesh. This outcome will encourage physicians, health-care professionals and health-educationists to inspire and persuade Bangladeshi T2DM individuals to get involved in aerobic and combined exercise programs to manage and lessen the complications of their cognitive functionality and enhance their quality of lives. In further research, larger sample including all seven divisions of Bangladesh could be incorporated to have more concrete results in understanding the comparative effectiveness of exercise interventions in complete improvement in cognitive functionality of the diabetic individuals.

## 6. LIMITATIONS

Every research has its own limitations. In the present study, very limited number of individuals, diagnosed as having T2DM for 7 - 10 years were included. Moreover, there was considerably higher percentage of female participants in the study. Therefore, the results may differ if more male participants participate in the future studies. A lot of co-morbidities were not included while selecting the participants. Moreover, only one division of Bangladesh was at focus to understand the impacts on visual-motor integration skills due to time constraint and logistical problems. Hence, it is quite difficult to have a comprehensive conclusion on the improvement in cognitive functionality for the entire Bangladeshi T2DM population.

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## 8. CONTRIBUTION OF AUTHORS

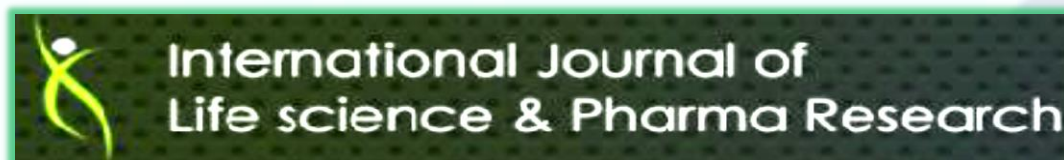
Conceived and designed the experiments: FaS, SS, SS  
 Collected data and performed the experiments: FaS  
 Contributed with materials/analysis tools: FaS, SS, SS  
 Analysed the data: FaS, SS  
 Wrote the manuscript: FaS  
 Checked and edited the format: FaS, SS  
 Final approval: FaS

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# IMPACT OF AWARENESS ON ATTITUDE AND BEHAVIOUR TOWARDS COVID-19 IN BANGLADESH

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COVID-19, Knowledge, Attitude,  
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## ABSTRACT

**Background:** The Coronavirus (COVID-19) pandemic is expected to be one of the most significant public health emergencies of the 21st century. Global efforts have been exerted to prevent the spread of the disease through a combination of governmental action and public education and awareness campaigns intended to increase knowledge and modify personal attitudes and behaviour.

**Aim:** This study sought to conduct a survey of Bangladeshis to assess the level of awareness about COVID-19 and evaluate the impact of awareness on perception, attitude, and behaviour.

**Method:** A cross-sectional survey of 82 Bangladeshis was performed during August of 2020 using a convenient sampling method. The survey data were then used to score the participants by comparing their responses against published facts and guidance about COVID-19 disseminated by international organizations (WHO and CDC) and the Bangladesh Government.

**Results:** The mean knowledge score was 13.25 out of 20, gained mainly through Television and Radio (76.8%), and social media (56.1%). Female respondents were found to be significantly more knowledgeable than men. Knowledge levels were found to be significantly higher in those with higher levels of education as well. However, age and income were found to have an insignificant impact on levels of knowledge in Bangladesh. Most participants (85.4%) were anxious or mentally stressed due to the perceived risk of Coronavirus (COVID-19) infection.

**Conclusions:** Those with more knowledge about the disease were found to be more likely to follow instructions and guidance but were more dissatisfied with the information being provided to them. Increased knowledge had little or no impact on levels of anxiety. The levels of awareness were found to be lower than socio-economically comparable countries like Malaysia and Egypt, but higher than that in Afghanistan.

## 1. INTRODUCTION

In December 2019, a highly infectious novel Coronavirus, SARS-CoV-2 emerged in Wuhan in the Hubei Province of China and has since rapidly spread across the world, giving rise to the ongoing global pandemic. As of now the disease caused by SARS-CoV-2, named COVID-19, has taken over 2,79,6561 lives around the globe<sup>1</sup>. In severe cases, the virus causes fatal pneumonia similar to that caused by SARS and MERS. But unlike those two previous Coronavirus outbreaks, global concerns about this Coronavirus have arisen due to its high transmission capability, which may be coupled with morbidity and mortality. As a result, the COVID-19 pandemic has become the most consequential public health emergency of the 21st century pushing the healthcare systems of many countries to their breaking points and causing global social and economic upheaval in its wake, including the largest global recession since the Great Depression. Given the novel nature of the disease and the scarcity of newly developed vaccines and effective treatment procedures, the governments of most countries have adopted mitigation strategies in order to stem the spread of the virus.

The mitigation measures include but are not limited to drastic lockdowns, movement control, mask and personal protection policies and shelter in place orders on citizens. In general, much of the mitigation and control strategies are based on the published recommendations and guidelines laid out by WHO and Centres for Disease Control and Prevention (CDC). Since the available vaccines and treatment are still facing insufficiency specially in developing countries, the importance of prevention, control and mitigation of the disease can hardly be understated.

Abdelhazf et al. in 2020 carried a survey named “Egypt: Knowledge, Perceptions, and Attitude of Egyptians Towards the Novel Coronavirus Disease (COVID 19)” to summarize data on socio-demographic characteristics and medical history and responses to questions concerning knowledge, perceptions, and attitude towards COVID 19. The survey demonstrated that novel channels including social media platforms, and the internet represented the most important sources of information, at the expense of more traditional media platforms; namely: newspapers. Facebook is the main social media platform in Egypt, and users of this platform increased from 33 million users in 2016 to more than 40 million in 2019.



The mean knowledge score among participants was significantly lower among older people, those living in rural areas, with lower educational and monthly income levels. They concluded that more effort should be exerted to deliver the message to these less knowledgeable members of the public, who most likely have technical and/or financial difficulties in getting access to the novel communication platforms mentioned above.

In contrast to the results obtained by Abdelhafz et al.<sup>2</sup> in Egypt, the findings of Ahmad et al.<sup>3</sup> show that, for the most part, the Afghan public is far less informed about COVID 19. Unlike the Egyptian study, only 40% of the respondents are aware of the disease. Furthermore, just 41% of the respondents are protecting themselves from infection with only 36% of women respondents indicating that they are aware of protection measures. 69% of the respondents (only 58% among women) are aware of the symptoms of COVID-19 and 52% of respondents mentioned that they are aware of ways of transmission of COVID-19. The study also found that up to 39% of the respondents may belong to the at-risk group, with men showing a higher likelihood of belonging to this category with 45% and women with 30%. Of those that are aware of the disease and its preventive measures, a large portion were knowledgeable about personal hygiene practices like washing regularly with soap and water and covering mouth and nose when coughing or sneezing. These respondents were also found to be informed about physical distancing requirements and indicated that they are likely to follow lockdown measures and avoid large gatherings if ill. 69% of respondents mentioned that they would visit the nearest hospital or health facility if they get sick. 23% mentioned that they would purchase medicine from the nearest drug store and 20% indicated that they would visit a medical quack and 17% would visit a shrine or traditional healer for treatment.

Azlan et al. in 2020<sup>4</sup> performed a similar cross-sectional online survey in Malaysia during late March and early April (approximately the same time period as the two earlier studies). The overall correct rate of the knowledge questionnaire was 80.5%. Most participants held positive attitudes toward the successful control of COVID-19 (83.1%), the ability of Malaysia to conquer the disease (95.9%) and the way the Malaysian government was handling the crisis (89.9%). Most participants were also taking precautions such as avoiding crowds (83.4%) and practising proper hand hygiene (87.8%) in the week before lockdowns began in Malaysia. However, the wearing of face masks was less common (51.2%). Another study done on Malaysian population by Bhagavathula et al.<sup>5</sup> on healthcare workers (HCWs) Surprisingly, the study found that a significant proportion of HCWs had poor knowledge of its transmission (61.0%) and symptom onset (63.6%) and showed positive perceptions of COVID-19. Given this caveat, it is entirely possible, in fact likely, that healthcare workers are still generally more knowledgeable than most members of the public. However, it does indicate that educational interventions are urgently needed to reach HCWs worldwide, and further studies are warranted. There is an extensive survey done on only the knowledge level of Bangladeshi population on COVID-19 Awareness and Economic Impact” by BRAC6 in 2020. The study results show that most respondents were aware of how the novel coronavirus spreads (fully aware 59%, partially 38%). Some gender-based variation was also noticeable with 67% of men being fully aware compared to 55% of women. Similarly, urban populations (64%) were slightly more aware than rural (58%). More than three fourth (76%) respondents always followed the general hygiene practices recommended to protect oneself from

coronavirus (such as washing hands with soap, social distancing, covering cough/sneeze, etc.). Some gender-based variation was also noticeable with 67% of men being fully aware compared to 55% of women. Similarly, urban populations (64%) were slightly more aware than rural (58%). More than three fourth (76%) respondents always followed the general hygiene practices recommended to protect oneself from coronavirus (such as washing hands with soap, social distancing, covering cough/sneeze, etc.). Some degree of confusion about treatment options also seems to be present among respondents. 11% of the respondents chose ‘Getting tested immediately’ as the appropriate response to developing COVID-19 symptoms while less than half of the respondents (42.6%) chose ‘home quarantine/isolation’. More than one fourth (26%) respondents believed that there is no treatment for the disease. Such belief is more prevalent among men (32%) and people in rural areas (30%) than women (23%) and urbanites (21%). 37% of the respondents thought that the district-level government hospitals do not treat COVID-19 patients. 23% (27% in rural areas compared to 14% in urban areas) respondents are uncertain about the availability of Coronavirus treatment in the government hospitals. This uncertainty is higher among women (27%) than men (16%). Interestingly, much like the Afghanistan Survey by Ahmad et al.<sup>4</sup>, the BRAC survey also attempted to capture perception about increased incidences of violence against women, indications of which have been reported globally and in Bangladesh in several studies.

From the aforementioned studies on knowledge and perception level of various populations of different countries shows that the effectiveness of mitigation efforts by these countries is inextricably tied to the cooperation and compliance of every one of its citizens and residents. Consequently, the public knowledge and awareness about COVID-19 is likely to play a vital role in determining a society’s readiness to accept and adapt to behavioural change measures recommended or ordered by health and government authorities. This work seeks to assess the extent of the awareness about COVID-19 in Bangladesh and examine the impact this has had on public attitudes and behaviours. In addition to contributing to society at large, such a study would help the Bangladeshi government and any other organizations trying to raise awareness about COVID-19 create more effective informational campaigns, target at-risk groups and design better programs to serve the public. It would also provide these institutions the data necessary to make internal changes to programs or policies that have thus far been ineffective.

Hence, the objective of this study is to conduct a survey of Bangladeshis to evaluate their sources of information, level of knowledge and their behaviour and attitudes about COVID-19.

## 2. METHODOLOGY

A cross-sectional survey was designed for the present study and was conducted during August 2020 among Bangladeshis.

### 2.1 Survey instrument

An online survey portal was created using Google Form and sampled participants were invited to complete and submit the form. However, because some members of the public either lack the means or the ability to access the online survey portal, an identical paper version of the survey was also used in order to obtain a larger and a more representative number of responses. To ensure greater accessibility, the survey form was also made available in both Bengali and English. Personal interviews were conducted in less affluent areas with necessary precautions to not endanger participants and limit the spread of the disease. The responses from these various sources were then compiled into a single data set.

### 2.2 Survey design

The survey consisted of multiple-choice questions divided into three distinct sections to gather data on background information, knowledge, and perception. The background information section (questions 1-9)

was used to collect non-personally identifiable demographic data to compare the knowledge, attitude and behaviours of different groups. The next section was designed to assess awareness or knowledge about COVID-19. The first 5 questions sought to determine the sources of knowledge. The next 20 questions were designed to establish the extent of knowledge and covered topics such as transmission routes, prevention, and control methods of the disease. The correct responses to these questions are based on published facts and guidance about COVID-19 disseminated by international organizations (WHO and CDC) as well as recommendations promulgated by the Bangladesh Government<sup>17</sup>. The respondents were then scored on a 20-point scale on these knowledge questions where a correct overall response was assigned 1 point while an incorrect/not sure response was assigned 0 points (partial points were awarded for questions with multiple correct answers).

The final section was designed to assess attitudes and perceptions about the level of knowledge about COVID-19 with specific emphasis placed on satisfaction about the level of available information and government initiatives.

### 2.3 Population and Sampling

Although the target population of the study was the Bangladeshi population, in order to limit the risks of spreading the disease, a convenient sampling method was used. Attempts to obtain a representative sample were made by targeting economically disadvantaged areas like the slums of Dhaka and Gazipur and remote areas through paper surveys. More affluent participants were reached by disseminating the online survey through social media.

### 2.4 Statistical Analysis

Descriptive statistical methods were used to summarize responses of socio-demographic groups to questions concerning knowledge, awareness, and attitude towards COVID-19. The data were summarized as frequencies (n) and percentages (%) for categorical variables and were plotted using bar charts and pie charts for visual presentation using Excel and Google Sheets. Student's t and ANOVA tests were used to determine the relation between mean knowledge score and socio-demographic variables.

### 2.5 Ethical Considerations

Respondent's anonymity and confidentiality were ensured. The submission of the answered survey was considered as consent to participate in the study.

## 3. RESULTS

The results of the survey are presented in the sections below, summarized as percentages (%) for categorical variables.

### 3.1 Socio-economic and demographic characteristics of participants

Since a representative sample of Bangladeshis was surveyed, a large majority (54.9%) of all respondents were 18–35-year-olds as shown in Figure 3.1. This is in accordance with the median age of Bangladeshis which is 27.1 years old (2018 estimate)<sup>7</sup>. However, female respondents outnumbered male respondents by 53.7% to 46.3% (see Figure 3.2). 51.2% of those surveyed indicated that they were married while 43.9% were unmarried as shown in Figure 3.3.

Students (31.7%) and employees (29.3%) make up an overwhelming majority of the occupations of the respondents which is also indicative of a young population (see Figure 3.4). Most respondents live in households that have either 5–8 people (58%) or 3–4 people (39.5%) which were higher than the global average of 3.1 but matches very well with the average household size of Bangladeshis (Fig. 3.5).

Many respondents chose not to reveal their household income, but among those that did a majority said that their household earns between 10,000 Tk to 30,000 Tk (Figure 3.6). The highest education qualifications of respondents is approximately equally distributed between class 10 or lower (35.4%), higher secondary certificate (23.2%) and bachelors or above (39%) (Figure 3.7).

### 3.2 Knowledge score differences in demographics of respondents

100% of respondents reported that they were aware of the Coronavirus (COVID-19) pandemic with an overwhelming majority (61%) indicating that they first learnt about the pandemic 6 months ago. Television or radio (76.8%) are their primary sources of receiving information about COVID-19, followed closely by social and other electronic media (56.1%) and newspapers (51.2%). 38.3% also revealed that they found television or radio to be the most reliable source of such information (Figure 3.9).

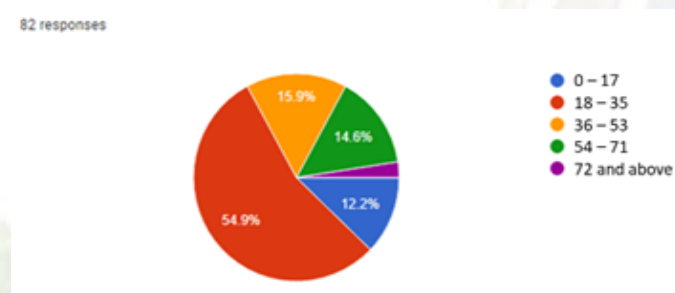


Figure 3.1: Ages of respondents

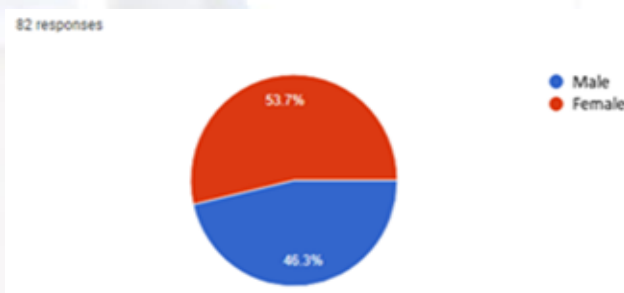


Figure 3.2: Gender of respondents

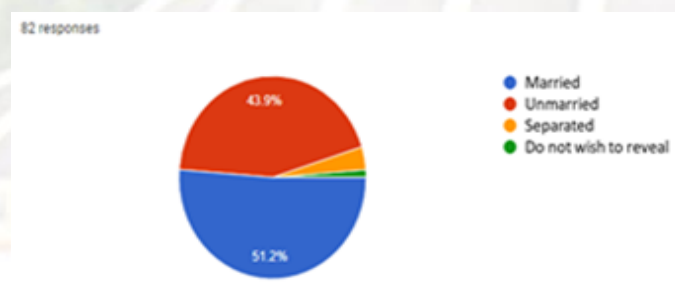


Figure 3.3: Marital status of respondents

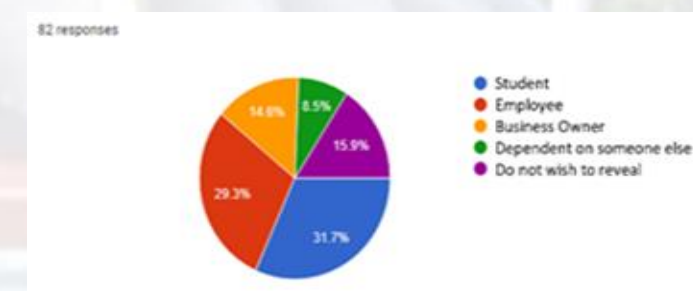


Figure 3.4: Occupation



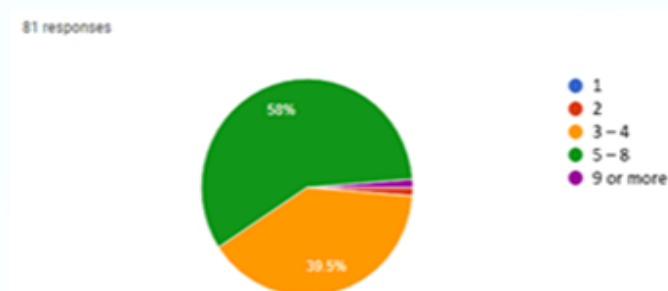


Figure 3.5: Size of household

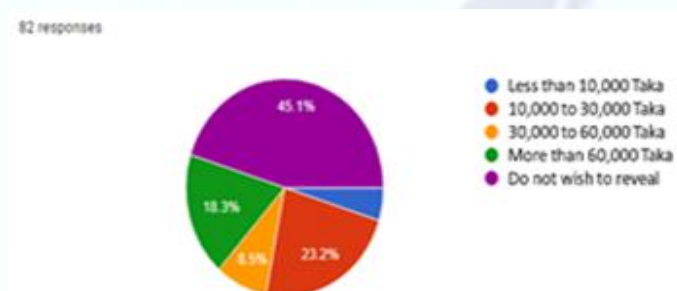


Figure 3.6: Total household incomes

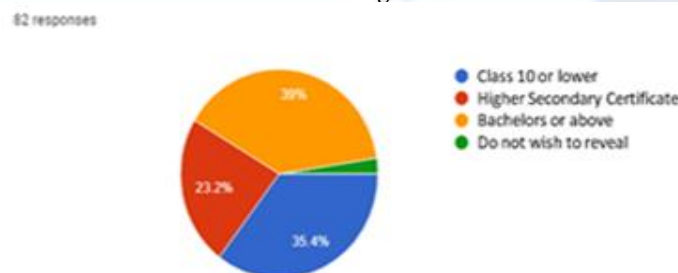
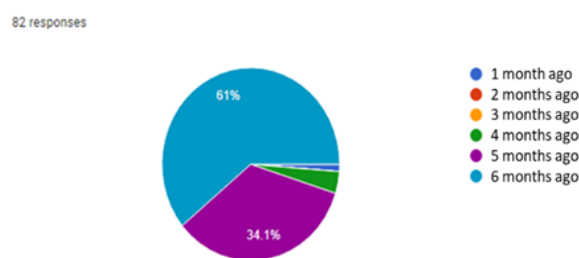
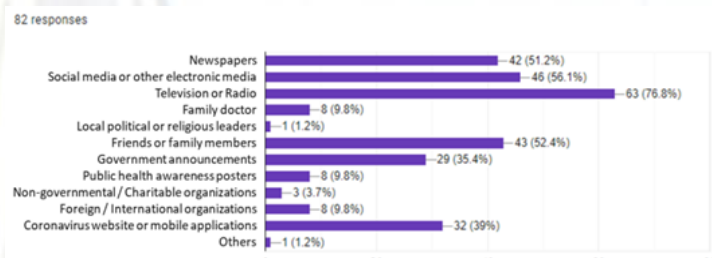


Figure 3.7: Educational qualification



(a)



(b)

Figure 3.8: Time when respondents first learnt the pandemic

81 responses



Figure 3.9 Respondents perceived reliability of these sources of COVID-19 information

The average knowledge score obtained was 13.25 out of 20. The knowledge question that most respondents answered correctly was whether masks ought to be worn to prevent the spread of Coronavirus (100% correct). The knowledge question that most respondents answered incorrectly was “Do most patients die after contracting coronavirus?”. 51.2% indicated that they were unsure what the ultimate outcome was, while the rest correctly noted that death does not commonly occur.

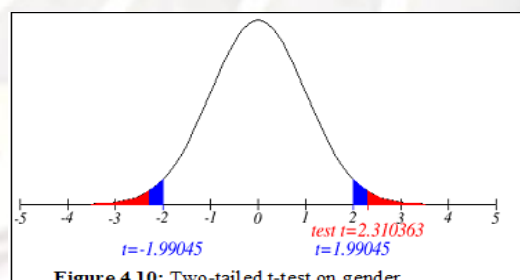


Figure 4.10: Two-tailed t-test on gender

	Male	Female
Mean	12.74	13.67
Variance	3.36	3.12
Count	37.00	44.00
t-statistic	2.31	
Degree of freedom	79.00	
Significance levels	5% two tailed test	
Critical values	-1.99 and 1.99	

Table 4.1: T-test on gender

A two-tailed student's T-test performed on the mean knowledge scores of males and females indicates that there is a significant difference in knowledge about Coronavirus at the  $p < 0.05$  significance level in these two groups. Females with a mean score of 13.67 are more knowledgeable about Coronavirus than males whose mean score is 12.74. Given the similarity in sample sizes and the variances of males and females, the research design in terms of the gender ratio is balanced, so it is unlikely for this particular test to be affected by heteroskedasticity.

However, as a convenient sampling method was used, it was not possible to ensure that other ways of grouping the sampled individuals would also be equal in size and variance. Consequently, where possible, Welch's ANOVA was used to test and compare the data to avoid errors arising from unequal

variance and heteroskedasticity. Table 2 shows the results of Welch's ANOVA performed on the mean knowledge scores obtained by different age groups. At the  $p < 0.05$  significance level, no significant differences in knowledge could be found between different age groups.

	0-17 year old	18-35 year old	36-53 year old	54-71 year old	72 and above
Count	10	44	13	12	12
Mean	12.80	13.51	13.35	12.76	12.08
Variance	2.68	4.01	2.76	2.32	6.38
F-statistic	0.603485078				
p-value	0.674730331				

**Table 4.2:** Welch's ANOVA for age indicates that there is no difference in knowledge between different age groups at the  $p < 0.05$  significance level

	Less than 10000 Tk	10000 to 30000 Tk	30000 to 60000 Tk	60000 Tk or more
Count	4	19	7	14
Mean	13.65	13.15	12.55	14.04
Variance	1.92	1.75	7.39	2.67
F-statistic	1.07540827			
p-value	0.402987449			

**Table 4.3:** Welch's ANOVA for income indicates that there is no significant difference in knowledge between different income groups at the  $p < 0.05$  significance level

Welch's ANOVA was also applied to different income groups and again the results revealed that there is no significant difference in knowledge scores when considering income. However, it is important to note that 45.1% of respondents chose not to reveal data about their household income and this group had to be excluded from the data set when performing the test. So, it is entirely possible that the relatively smaller sample size is responsible for causing the analysis of this data to be inconclusive.

Finally, a one-way ANOVA as well as Welch's ANOVA was

performed for mean knowledge scores obtained by groups with different levels of education. Here, both of these tests indicate that there is a significant difference in mean knowledge scores as groups with lower levels of education scored worse than groups with higher levels of education. The reason for performing both tests is that, although the differences in size and variances of the groups assessed by the tests are minimal, it could possibly still be significant (A Levene's test for unequal variances produces a p-value of 0.68 for the data set in question, which is borderline). For the purposes of these tests, the 2 respondents that chose not to reveal their education levels were included in Class 10 or lower.

	Class 10 or lower	Higher Secondary Certificate	Bachelors and above
Count	31	19	31
Mean	12.61	13.59	13.68
Variance	2.39	4.72	3.17
F-statistic	4.159311806		
p-value	2.73		

**Table 4.4:** One way ANOVA for education indicates that there is a significant difference in knowledge between groups with different education levels at the  $p < 0.05$  significance level

### 3.3 Relationship between knowledge scores and attitudes and behaviour

In order to evaluate the impact of their knowledge or awareness on attitudes or behaviour, respondents were asked to score themselves on their adherence to instructions and guidance received from news media, governmental and

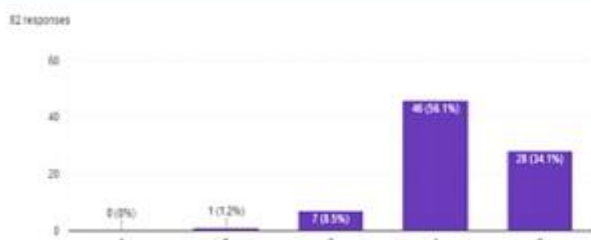
nongovernmental organizations. A majority (56.1%) of those surveyed selected a score of 4 whereas 0% admitted to not following any instructions. As shown in Figure 4.12, mean knowledge scores and self-reported observance of instructions are slightly correlated indicating that more knowledgeable individuals are slightly more likely to follow guidance about COVID-19.

	Class 10 or lower	Higher Secondary Certificate	Bachelors and above
Count	31	19	31
Mean	12.61	13.59	13.68
Variance	2.39	4.72	3.17
F-statistic	3.637637608		
p-value	0.034916031		

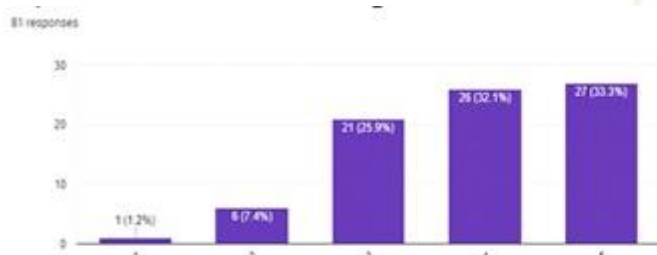
**Table 4.5:** Welch's ANOVA for education indicates that there a significant difference in the level of knowledge between groups with different education levels at the  $p < 0.05$  significance level



Respondents were also prompted to rate their satisfaction about information received from news media, governmental and nongovernmental organizations. Here, the results are more mixed with 33% selecting a score of 5, 32.1% selecting 4 and 25.9% selecting 3. As shown in Figure 4.14, satisfaction about information disseminated by news media, governmental and nongovernmental organizations displays a downward trend with increasing knowledge scores. This suggests that more knowledgeable individuals are relatively dissatisfied with the information that is being promulgated by these institutions.

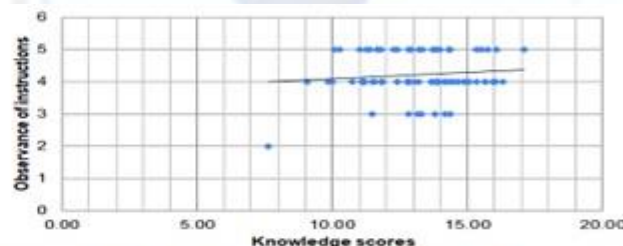


**Figure 4.11:** Respondents' self-assessed observance of instructions and guidance (COVID-19) (on a scale of 1-5) received from news media governmental and NGOs

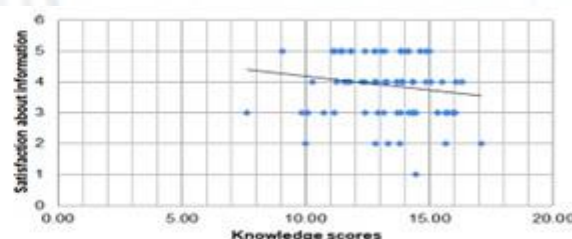


**Figure 4.13:** Respondents' satisfaction (on a scale of 1-5) about information received from news media, governmental and NGOs

When asked what their causes of concerns were during the ongoing Coronavirus (COVID-19) crisis, disruption to education was voted as the topmost cause (56.1%) while risk of illness was selected the least (25.6%). Although not a leading cause for concern, risk of illness still seems to be having an indirect impact as most respondents (85.4%) indicated that they were experiencing some form of anxiety or mental stress due to the perceived risk of Coronavirus (COVID-19) infection. As shown in Figure 4.17, the mean knowledge scores of those are anxious or stressed and those are not approximately equal, implying that having greater awareness about the pandemic does not necessarily reduce anxiety in any way.

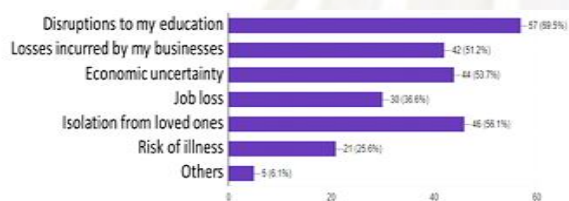


**Figure 4.12:** Self-reported levels of observance of instructions and guidance against their knowledge scores



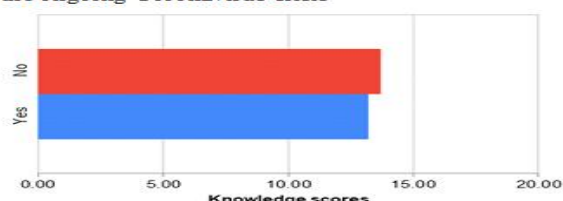
**Figure 4.14:** Respondents' satisfaction about information compared against their knowledge scores

Reassuringly, virtually all respondents indicated that they were taking some action to improve physical and mental health during the ongoing crisis, with most (81.7%) selecting 'eating healthy and nutritious food' as their topmost choice. Physical exercise, however, was only selected by 13.4% of those surveyed while 4.9% admitted to doing nothing to improve their physical and mental health.



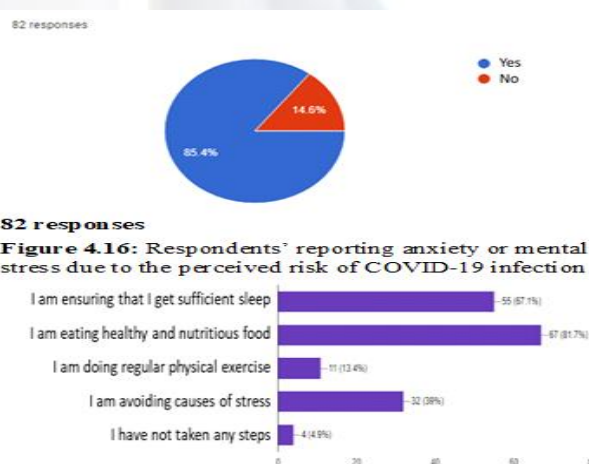
82 responses

**Figure 4.15:** Respondents' causes for concern during the ongoing Coronavirus crisis



**Figure 4.17:** Respondents' reported anxiety or mental stress about COVID-19 compared against their knowledge scores

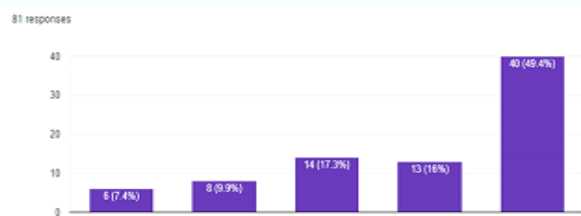
Nearly half the people (49.4%) surveyed reported that they were extremely satisfied with the Bangladeshi Government's initiatives and plans to curb Coronavirus giving them a rating of 5 out of 5. However, as shown in Figure 20, satisfaction levels have a downward trend line when compared against mean knowledge scores. This suggests that people who are more knowledgeable about the pandemic are less satisfied with Government action.



**Figure 4.16:** Respondents' reporting anxiety or mental stress due to the perceived risk of COVID-19 infection

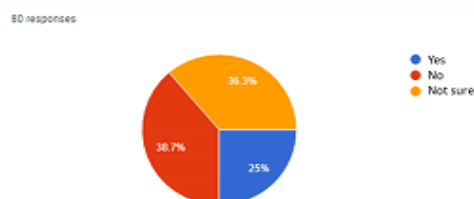


**Figure 4.18:** Actions taken by respondents to improve physical and mental health during the ongoing Coronavirus crisis



**Figure 4.19:** Respondents' satisfaction (on a scale of 1-5) about the initiatives and plans undertaken by the Government to combat the spread of Coronavirus

When asked if they would be willing to participate in a Coronavirus (COVID-19) vaccination trial, respondents expressed their misgivings about the trial with 25% opting or



**Figure 4.21:** Respondents' willingness to participate in a COVID-19) vaccination trial

An overwhelming majority (90.2%) of respondents expressed a desire for further news, information, and guidance from the Government about the Coronavirus (COVID-19). This and the

## 4. DISCUSSION

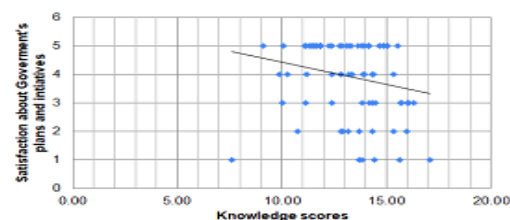
The results of the survey have revealed some useful insights about awareness and perception about the ongoing COVID-19 pandemic.

### 4.1 Explanation of general trends found by the current survey

In general, females were observed to be more knowledgeable about the disease. This is likely due to the fact that females are, in general, more conscious about health risks and therefore have paid more attention to awareness campaigns about COVID-19. An alternative explanation could be that, even prior to the pandemic, there existed a larger number of social welfare groups in Bangladesh that have been educating women about taking diseases and illnesses seriously. Consequently, the female demographic may have been primed to be more receptive to awareness campaigns than men. If true, this would call for a similar targeting of males in future health-related awareness campaigns as it might also have a 'priming effect' on them.

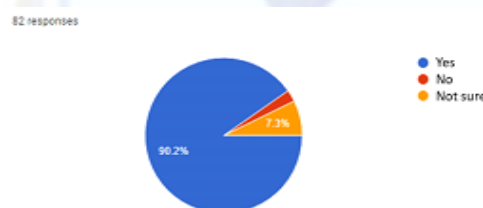
Unsurprisingly, those with higher levels of education were also found to be more knowledgeable. The effectiveness of pandemic awareness campaigns crucially depends on the target audience's prior understanding of biology, ability to think critically and comprehend the gravity of the underlying message. So, it is expected that those with higher levels of education would also absorb and implement the guidelines and recommendations presented in such campaigns.

Interestingly, both household income and age seem to have no bearing on levels of awareness. While, at a first glance, this might seem strange, especially when compared to some of the other studies, one has to look no further than the sources of information for a plausible explanation. In Bangladesh, the top source of information cited by respondents are television and radio followed closely by social media, which is usually the top most cited news source in many countries. Therefore, it is likely that,



**Figure 4.20:** Respondents' satisfaction about the plans and initiatives undertaken by the Government to combat the spread of COVID-19 compared against their knowledge scores

“Yes”, 38.7% saying “No” and the rest indicating that they were unsure.



**Figure 4.22:** Respondents' desire for further news, information, and guidance from the Government about (COVID-19)

relatively low level of knowledge suggests that much more ought to be done about informing the public about the pandemic.

because of the availability of inexpensive and accessible national TV channels and radio stations, information has reached lower income groups and those that are not tech savvy enough to have a social media presence.

It was also found that those with higher levels of knowledge were slightly more likely to follow instructions and guidance but were also more dissatisfied with the information being promulgated by various local authorities and news media. Of course, it is perfectly understandable and somewhat gratifying to see that those with more knowledge are more likely to follow instructions. The dissatisfaction found among knowledgeable individuals could be stemming from a number of concomitant factors. It could be that none of the organizations from which they have gathered information are providing relevant guidance in a comprehensive manner and that these individuals had to, essentially, cobble together information gathered from various sources to enhance their knowledge. It could also indicate distrust of these sources - perhaps due to the fact that instructions provided have changed, sometimes because of the changing nature of the available science and at other times because of self-serving motivations of those in authoritative positions. A related reason for dissatisfaction could be that the changing information is not frequently updated by these sources as and when new facts are known.

Respondents were also found to be anxious about the ongoing pandemic and this might be tied to the fact that so few of the respondents have increased or taken up physical exercise. This suggests that the importance of physical exercise as a way to relieve mental anxiety and boost physical immunity has not been sufficiently emphasized in awareness campaigns in Bangladesh. Also, when reported anxiety was compared against knowledge scores, it seemed to suggest that knowing more about the diseases does not reduce or increase anxiety significantly. This might be due to the fact that, while it is reassuring to know more about the dangers of the diseases, the nature of the disease itself increases the levels of concern. It is possible that the two effects are negating each other's influence on anxiety levels.



## 4.2 Comparison with studies conducted in other countries

The survey data can also be an important basis for comparison with similar knowledge, perception, and awareness (KAP) surveys conducted elsewhere. It is important to mention that there are limited number of KAP studies available on the similar socio-economic outlook to have a comparative perspective for the results received from this population. Although the present survey was smaller in terms of sample size, the demographics of those surveyed was in some respects comparable to that done in Egypt by Abdelhafiz et al.<sup>2</sup> Like the present study, they too had a plurality of females among their respondents. However, their research design was significantly unbalanced as nearly two thirds (62.3%) were females. Also similar was the fact that around half the participants (48.1%). While there were some differences in the knowledge assessment questions asked of the participants, the mean knowledge score obtained by Egyptians was markedly better (16.39 out of 23 i.e. 71.26%) than that obtained by Bangladeshis (13.25 out of 20 i.e. 66.25%) in the present survey. Like the Bangladeshis surveyed here, all Egyptian participants claimed that they had heard about COVID-19 and an overwhelming majority (86.9%) were concerned about the risk of infection. Unlike the participants in Bangladesh, the mean knowledge score was significantly lower among older participants and those with lower monthly income levels. In Egypt. Another major point of difference was the finding that almost similar knowledge mean scores were observed for male and female participants in Egypt ( $16.27 \pm 2.63$  and  $16.46 \pm 2.62$  respectively) with no statistically significant difference. However, in both countries, those with lower education levels scored worse than those with higher education levels. Despite the higher levels of knowledge in Egypt, only about three-quarters of participants believed that putting a face mask can protect from infection compared to a 100% of participants in Bangladesh. When asked about their perceptions regarding infection with the virus, most Egyptians participants believed that it represents a life-threatening danger which is similar to beliefs among Bangladeshis surveyed in the present study.

In contrast to Bangladeshis who have largely relied upon television and radio as the primary source of information regarding COVID-19, 61% of Afghans mentioned that health workers are the major source of information, according to the study by Ahmad et al. (2020)<sup>3</sup> The number of participants surveyed in Afghanistan was smaller than that in the present study (75) and were predominantly male (56%). Unlike the Egyptian study and the present work, they found very low levels of COVID-19 awareness (40%), with males being more well informed (48%) compared to females (30%). In Afghanistan, Health facility staff (89%) were considered the most trustworthy followed by Mass Communication tools like Radio/Television (75%), and next is the social platforms like WhatsApp, Facebook (52%) and are followed up by religious leaders (37%) and community elders (24%). This trust in religious leaders is in stark contrast with the result of the present study in Bangladesh where 0% of participants indicated they trusted them to provide accurate information on the topic. The perceived risk of infection was also markedly lower (59%) among Afghans compared to those surveyed in the present work. Despite not being as concerned, compared to Bangladeshis, Afghans reported more disappointment with the response from their government, as only 27% approved actions of their government.

The study by Azlan et al. (2020)<sup>4</sup> had a very large sample size (4850) but still shares noteworthy similarities with the current work. They too surveyed a relatively young group of people with a plurality of females (57.9%) compared to males. Their results indicate that Malaysians are far more knowledgeable about Coronavirus than Bangladeshis with an 80.5% correct rate of

knowledge. They were also comparatively more satisfied with the way their government has been handling the crisis (89.9%) than Bangladeshis. Unlike the data obtained by the Bangladeshi survey above, knowledge scores of those who were unsure whether the Government could control the spread of the virus was significantly lower than those who agreed that the virus would be successfully controlled. Adherence to COVID-19 guidelines was found to be greater among younger Malaysians and those earning below RM3,000 monthly which also does not match the results in Bangladesh where neither age nor income had a significant impact on knowledge score. In fact, those with low monthly income scored among the lowest knowledge scores. In terms of perception, just a little more than half of the participants reported wearing a face mask when going out in public (51.2%). This confusion may have happened because a majority of participants reported that they practised proper hand hygiene by frequently washing their hands and using hand sanitiser (87.8%) with females, people between the ages 18 to 29 and students showing a greater propensity to follow safety precautions. This is partially consistent with the findings in Bangladesh.

As discussed in Section 2, Bhagavathula et al.<sup>5</sup> surveyed 529 participants, an overwhelming majority of whom were healthcare workers (453). The gender balance was 51.6% males and 48.3% females. The participants were also predominantly young as was the case in the current work. Unlike Bangladesh where most participants reported receiving COVID-19 information from television and radio, most participants in their survey (276 i.e. 61.0%) used social media to obtain information on COVID-19. As in the present study, virtually all participants (97.8%) had heard about COVID-19. The knowledge scores among healthcare workers was, in general, higher than that of Bangladeshis surveyed here but, was unexpectedly, lower than what would be considered acceptable for healthcare workers. For instance, 88.5% were aware that in most cases COVID-19 is not fatal, which participants in the present study were largely unsure about. However, only 86.1% of doctors were aware that washing hands could prevent the spread of Coronavirus. And even more shockingly, only half (52%) of the healthcare workers aged 45-65 years believed that the symptoms of COVID-19 appeared as early as 2 or as late as 14 days. Comparatively, 51.2% of Bangladeshis surveyed in the current study were aware that infected patients could be asymptomatic and 92.7% were aware that an infected person could remain contagious for up to 14 days. These surprising findings are almost certainly a result of the fact that the study by Bhagavathula et al.<sup>5</sup> was conducted in March and the present study was conducted in August of 2020.

## 4.3 Comparison with other studies conducted in Bangladesh

There have not been very many extensive studies on knowledge, perception, and awareness about COVID-19 since the inception of the pandemic except the study conducted by BRAC<sup>6</sup>. Their research had an imbalance in terms of gender ratio as 37.5% of the survey respondents were men, and 63.5% are women, compared to 46.3% men and 53.7% females in the present work. Mean age of respondents in their study was 37 years (40 years for men, 36 years for women) which is older than those surveyed in this work. Average family size, however, was approximately the same (5). Although they did not conduct a comprehensive knowledge assessment as was done here, the BRAC study found that men (67%) were more aware than women (55%). This difference can be attributed to the relatively lower numbers of men surveyed in their work, as it is entirely possible that the awareness levels could be a lot closer in reality. Their study found that 44% of the respondents would recommend taking people close to them displaying COVID-19 symptoms to go to a hospital compared to 33% in the current study. However, 80.2% of respondents of the present study astutely chose the option of recommending possible COVID-19 patients to a government sanctioned testing facility first. This difference could be due to the perceived risk of going to the hospital first or the increased awareness of not overburdening the hospitals. The majority (63%) of the respondents in their study also felt that measures taken by the government to handle the situation induced by the pandemic are

adequate or somewhat adequate. This is virtually identical to what was found in the present study where 65.4% rated the government's plans and initiatives 4 or higher on a scale of 5.

In general, it seems that levels of knowledge about COVID-19 have improved compared to the study conducted by BRAC. However, without an identical knowledge assessment, it is impossible to make this claim conclusively and further studies later into the pandemic might reveal to what extent awareness efforts are having a positive effect.

## 5. CONCLUSION AND RECOMMENDATIONS

This study conducted a survey of Bangladeshis to assess the level of awareness about COVID-19 and evaluate the impact of awareness on perception, attitude, and behaviour. This study therefore recommends that any institutions seeking to raise awareness about the pandemic ought to ramp up their awareness campaigns and start tailoring their messaging to target lower educated males, who are likely to contract the disease because of their lack of knowledge. It may also provide an understanding to the policy makers to comprehend that awareness campaigns should closely examine if their efforts are faltering due to factual errors, inadequate information, infrequent updates or underlying biases, all of which could be causing respondents with more knowledge about the subject being dissatisfied.

## 6. CONTRIBUTION OF AUTHORS

Conceived and designed the experiments: PrI, YbB, FaS

Collected data and performed the experiments: PrI

Contributed with materials/analysis tools: PrI, YbB, FaS

Analysed the data: PrI, YbB

Wrote the manuscript: PrI

Checked and edited the format: FaS, PrI

Final approval: FaS

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## EFFICACY OF EXERCISE INTERVENTIONS IN PERCEIVED HEALTH-STATUS AMONG BANGLADESHI INDIVIDUALS WITH TYPE 2 DIABETES MELLITUS

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### KEYWORDS:

Aerobic Exercise, Combined Exercise,  
EuroQol 5D-5L, Perceived Health Status,  
Type 2 Diabetes Mellitus, Bangladesh

### ABSTRACT

**Background:** Diabetes mellitus (DM), a lifestyle-related disease imposes an enormous social and economic impact on countries around the world. The prevalence of DM is growing in both rural and urban Bangladesh. The quality of life is getting hugely compromised due to the pervasiveness of this disease.

**Aim:** The purpose of the study is to make a comparison of aerobic and combined exercise intervention programs to understand the effects in the perceived health status of diabetic population

**Method:** This interventional study was carried out with 66 middle aged participants having Type 2 Diabetes Mellitus(T2DM) with middle income status residing in Dhaka, Bangladesh. There was 14 weeks of intervention sessions along with another 14 weeks of no intervention session to evaluate the sustainability of the intervention programs. The EuroQol 5D-5L questionnaire was used to measure the advancement in the perceived health status of the targeted population. Wilcoxon signed-rank test and Two-way repeated measures of ANOVA/ Mixed factorial ANOVA were used to analyse the data.

**Results:** After 14 weeks of aerobic exercise, significant improvement in the state of mobility ( $p = 0.000$ ), maintaining self-care ( $p = 0.001$ ) and the level of anxiety ( $p = 0.000$ ) was observed. In case of combined exercise program, post-intervention improvements in perceived sense of mobility ( $p = 0.010$ ) and anxiety ( $p = 0.010$ ) were observed. In comparison between aerobic and combined exercise program ( $p = 0.000$ ), significant difference observed at the post intervention phase with negative mean differences indicating higher values detected for combined group of participants.

**Conclusions:** It can be concluded that combined exercise program had shown the best outcome in enhancing the health status of the participants compared to aerobic and control group in this study.

## 1. INTRODUCTION

In the recent years Diabetes Mellitus (DM) has emerged as one of the four major non-communicable diseases (NCDs) which encompass the principal contribution to morbidity and mortality around the world<sup>1</sup>. According to the World Health Organization (WHO)<sup>2</sup>, about 422 million people worldwide are facing the complications of diabetes and the majority of them are residing in low-and middle-income countries. On top of those 1.6 million deaths are directly attributed to diabetes every year. The prevalence and the number of cases of diabetes have been gradually increasing over the past few decades. The global prevalence of diabetes increased from 4.7% in 1980 to 8.5% in 2014 among the adults aged from 18 years and above<sup>2</sup>. In terms of premature mortality from diabetes, there was a 5% increase between the years 2000 and 2016 both in high-income and lower-middle income countries. Regrettably, more than 80% of deaths related to diabetes takes place in low- and middle-income countries around the world<sup>1</sup>.

Bangladesh is a lower middle-income country with a considerable amount of burden of population of more than 160 million and is among the top ten countries with the highest number of adults with diabetes worldwide<sup>3</sup>. Similarly, like rest of the world, there is a significant rise in the prevalence of diabetes among the adults in Bangladesh. According to available statistics, there are about 7.1 million adults in Bangladesh who are affected by diabetes and this percentage is predicted to surge to 13.6 million by 2040<sup>4</sup>. There are also evidences that prevalence of type 2 diabetes mellitus (T2DM) is increasing in both rural and urban areas of Bangladesh<sup>5</sup>. A scoping review (1994-2013)<sup>1</sup> showed that the prevalence of T2DM in Bangladesh varied from 4.5% to 35.0%. This heavy burden of diabetes creates challenges in the health care management and expenditure which leads to economic burden on the healthcare systems and also on individual lifestyle. T2DM leads to certain acute and chronic complications like cardiovascular disease, blindness, kidney failure, and lower limb amputation in most of the cases<sup>4</sup>.

Hence, the rise in diabetes prevalence also emphasises in increasing the chronic diabetic complications of people in Bangladesh. It becomes extremely important that people are aware of this metabolic distress as this disease may stay dormant or undiagnosed due to its insidious nature until any complications appear<sup>6</sup>. According to IDF, people aged between 45-60 years leads to the highest portion of the diabetic scenario in Bangladesh. Meanwhile, globally, a growing population over the age of 60 makes up the largest proportion of diabetes prevalence<sup>4</sup>.

The way of tackling the various complications induced by T2DM and to lead a healthy life style, people require to have constant self-care, medical care and awareness regarding the management of this disease<sup>7</sup>. One of the three keystones of diabetes therapy is exercise along with medication and diet<sup>8</sup>. The American Diabetes Association (ADA)<sup>9</sup> and American College of Sports Medicine (ACSM)<sup>10</sup> have recommended sets of physical activities and exercises to control and manage the level of blood sugar from quite a long period of time. The cost-effective nature of exercise interventions further enhances the therapeutic appeal to manage this disease. Several diabetic literatures have shown positive impacts in the biological indices of T2DM population who were involved in various kinds of aerobic exercises like walking and also combined exercise regimes (resistance and aerobic exercises). Having said that the impacts of exercises may differ based on the nature of components and protocols used for the exercises on different segments of T2DM population.

Previously several studies were done to assess various aspects of T2DM and its effects on physical and psychological indices. Yet, there are an insufficient number of studies in assessing the perceived sense of well-being of diabetic population. It is important to understand the perceived sense of health status because this disease infers massive strains on the overall psyche of an individual. Till date there was no interventional research done on the Bangladeshi T2DM population to measure and recommend alternatives to improve the health status from self-perceived health status perspective. Thus, it becomes essential to evaluate various alternatives which can be useful for the T2DM population from self-perceived health status perspective. Therefore, the present study took an attempt to evaluate the effects of different exercise interventions on the enhancement in perceived health status of the middle-aged individuals with type 2 diabetes in Dhaka, Bangladesh.

## 2. METHODOLOGY

### 2.1 Participants

In the study, considering the possibilities of dropout rates, altogether approximately 123 participants were invited for the intervention. Participants were invited from the outpatient department (OPD) of the Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorder (BIRDEM) General Hospital and then all the participants were assessed based on the pre-defined inclusion and exclusion criteria (Refer to Sultana, 2018 for complete list of inclusion and exclusion criteria). Ethical approval for this study was obtained from the Bangladesh Institute of Sports Science (Ref.no.BISS/ACEC/0104). The flow of the assessment started with random categorization of selected participants into three different groups. The three groups were: Group A: Control group (received no intervention); Group B: Experimental Group I (received aerobic exercise training i.e. walking) and Group C: Experimental Group II (received combined exercise, i.e. aerobic exercise training and resistance/strengthening exercise training).

There was a concealed allocation of the experimental groups and the participants, researcher and the trainers for the study were blinded. All the training intervention sessions were supervised and monitored by qualified exercise trainers. Participants of the study were given complete freedom to withdraw themselves from the study whenever they felt any uneasiness.

### 2.2 Assessment Protocol & Intervention Technique

The EuroQol 5D-5L (EQ 5D-5L) questionnaire<sup>11</sup> was used to assess the perceived health status of the T2DM participants in Dhaka, Bangladesh. There are five dimensions (mobility, anxiety/depression, usual activities, self-care and pain/discomfort) in that questionnaire and each dimension consists of five statements. The numerals do not possess any arithmetic properties and cannot be used a cardinal score. This questionnaire also has a Visual Analogue scale named as EQ VAS. EQ VAS has two endpoints and the range of values is between 0 to 100 points denoting perceived worst health to perceived best health of a respondent. Two different exercise interventions (aerobic and combined training) were practised in this study for two different intervention groups following a standardised protocol. The detail information regarding the intervention technique can be found in Sultana et al., 2018<sup>12</sup>.

### 2.3 Data Analysis

Statistical Package for the Social Sciences (SPSS) version 23.0 was used for analysing the data. Normality and homogeneity of variance of the data were analysed before the main analysis. Assumption of normality was carried out by using Shapiro-Wilk test ( $p > 0.05$ ) and assessment for homogeneity of variance was carried out by Mauchly's Test of Sphericity ( $p > 0.05$ ). Wilcoxon signed-rank test and Two-way repeated measures of ANOVA/ Mixed factorial ANOVA were used to examine the available data. The significance level for all the analysis was set at  $p < 0.05$ .

## 3. RESULTS

At the end of the data collection period, 66 participants from Dhaka, Bangladesh, 21 males (31.8%) and 45 females (68.2%) with a mean age range of 55 years ( $54.90 \pm 4.18$ ) were recruited. Amongst them, 11 (16.7%) participants were within the age-range of 40-50 years and the rest 55 (83.3) were within the age-range of 50-60 years. The mean BMI was 27.35 (kg/m<sup>2</sup>) of these participants with 22 (33.3%) people in normal BMI range, 23 (34.8%) people were overweight and the remaining 21 (31.8%) participants were categorised as obese. Together with that the mean height of the participants was 155.32 cm and weight was 65.65 kg. Alongside, the average duration of T2DM in Bangladeshi participants was also 8 years ( $8.00 \pm 1.16$ ) with mean HbA1c level of 9.85 % (Table 1).

In regard to study participants who were considered under the aerobic exercise group, the frequency of T2DM individuals from pre-to post intervention who have reported "no problems" in mobility (pre =32%; post = 72%), maintaining self-care (pre =20%; post = 60%), continuing activity (pre =40%; post = 64%) and anxiety level (pre =40%; post = 100%) have increased. Only the frequency of participants from pre-to post intervention who have reported "no problems" in the level of pain (pre =60%; post = 44%) have decreased. On the other hand, the frequency of participants from post intervention to follow up phase who have reported "no problems" in mobility (post =72%; FU = 62.5%), maintaining self-care (post =60%; FU = 54.2%) pain or discomfort (post =44%; FU = 41.7%) and continuing activity (post = 64%; FU = 50%) have decreased. However, the frequency of participants from post intervention to follow up phase who have reported "no problems" in the level of anxiety remained the same at 100%.



**Table 1**  
**Socio-Demographic data of the T2DM population**

Variables	Overall N=66	Control (No Exercise) Group n=22	Aerobic Exercise Group n=24	Combined Exercise Group n=20
	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD
Gender				
Male	21 (31.8)	5 (22.7)	8 (35.3)	8 (40)
Female	45 (68.2)	17 (77.3)	16 (66.7)	12 (60)
Age (Years)	54.90 $\pm$ 4.18	53.15 $\pm$ 4.90	54.75 $\pm$ 3.31	56.80 $\pm$ 3.49
40 -50	11 (16.7)	8 (36.4)	4 (16.67)	1 (5)
51 – 60	55 (83.3)	14 (63.6)	18 (83.33)	19 (95)
BMI (kg/m <sup>2</sup> )	27.35 $\pm$ 4.69	29.80 $\pm$ 4.08	26.16 $\pm$ 4.57	26.09 $\pm$ 4.61
Underweight	0 (0)	0 (0)	0 (0)	0 (0)
Normal	22 (33.3)	4 (18.2)	9 (37.5)	9 (45)
Overweight	23 (34.8)	9 (40.9)	7 (29.2)	7 (35)
Obese	21 (31.8)	9 (40.9)	8 (33.3)	4 (20)
Height (cm)	155.32 $\pm$ 8.93	156.00 $\pm$ 6.63	154.70 $\pm$ 9.61	155.25 $\pm$ 10.51
Weight (kg)	65.65 $\pm$ 10.69	72.25 $\pm$ 8.38	62.30 $\pm$ 10.76	62.40 $\pm$ 9.99
Diabetic year (Years)	8.00 $\pm$ 1.16	8.10 $\pm$ 1.25	7.80 $\pm$ 1.06	8.10 $\pm$ 1.21
HbA1c (m.mol/l)	9.85 $\pm$ 1.64	9.95 $\pm$ 1.73	9.84 $\pm$ 1.54	9.76 $\pm$ 1.73
Monthly Income (BDT)	28066.67 $\pm$ 7506.53	27880.00 $\pm$ 8327.10	27880.00 $\pm$ 7586.25	28440.00 $\pm$ 6918.35

Total number of participants was 66. They were categorized into Control (n=22), Aerobic exercise (n=24) and Combined exercise group (n =20)

**Table 2**  
**Pairwise Comparisons for EQ-VAS Score across different groups based on phases**

Phases	Groups	MD (95% CI)	p-value
Pre	Control - Aerobic	3.80 (-4.04,11.64)	0.0710
	Control - Combined	11.55 (3.71,19.39)	0.062
	Aerobic – Combined	7.75(-0.09,15.59)	0.063
Post	Control - Aerobic	-12.15(-18.65, -5.65)	0.000**
	Control - Combined	-3.90(-10.60, -2.40)	0.432
	Aerobic – Combined	-8.25(-1.75, -14.75)	0.008**
Follow-up	Control - Aerobic	-11.25 (-18.69, -3.19)	0.001**
	Control - Combined	-6.00(-13.44, -1.44)	0.155
	Aerobic – Combined	-5.25(-12.69,2.19)	0.262

\* $p < 0.05$ ; \*\* $p < 0.001$

Two-way repeated measure of ANOVA between group analysis regarding phases were applied followed by pairwise comparisons with 95% confidence interval adjusted by Bonferroni correction. Assumption of normality, homogeneity of variances and compound symmetry were checked and fulfilled.

Now, considering the statistical significance of the self-reported health-status, between pre to post intervention phase, the state of mobility ( $p = 0.000$ ), maintaining self-care ( $p = 0.001$ ) and the level of anxiety ( $p = 0.000$ ) had a statistically significant difference in outcome; between pre and follow up phase only the state of mobility ( $p = 0.003$ ), maintaining self-care ( $p = 0.001$ ) had a significant difference and between post intervention and follow up phase only the state of mobility ( $p = 0.024$ ) had a significant difference among the Bangladeshi T2DM individuals categorized in the aerobic exercise group (Refer to data table at DOI: <https://dx.doi.org/10.13140/RG.2.2.32026.98240>).

Now, pertaining to the statistical significance of the self-reported health states, between pre to post intervention phase, the state of mobility ( $p = 0.010$ ) and the level of anxiety ( $p = 0.010$ ) had statistically significant differences in outcome; between pre and follow up phase also only the state of mobility ( $p = 0.026$ ) and the level of anxiety ( $p = 0.010$ ) had significant differences and finally between post intervention and follow up phase there was no significant difference among the T2DM individuals categorized in the combined exercise group (Refer to data Table at <https://dx.doi.org/10.13140/RG.2.2.32026.98240>).

Table 2 below depicts that during the pre-intervention phase there was no significant difference between various groups in the study. In the post intervention phase, there were significant differences observed between control and aerobic group ( $p = 0.000$ )

and also, between aerobic and combined group ( $p = 0.008$ ) with negative mean differences indicating higher values in the aerobic and combined group respectively.

Also, in the follow up phase there was a significant difference between control and aerobic group ( $p = 0.001$ ) with negative mean difference signifying higher values in the aerobic group compared to the control group. Even though there was no statistically significant difference between aerobic and combined group in follow up phase, but negative mean difference illustrates that the score for EQ-VAS was higher in combined group than aerobic group in the study results.

#### 4.DISCUSSION

The purpose of the study is to assess the impacts of aerobic and combined exercises in perceived health status of T2DM participants in Dhaka, Bangladesh. In this research EQ-5D- 5L<sup>41</sup> was employed to assess consequences of different exercise intervention methods across several phases and groups to find out probable significant improvements in different dimensions of health status.

The result of this study showed that the perceived level of mobility improved among the participants in the aerobic group. The cause of this perceived improvement in mobility could be multifaceted. Firstly, individuals with T2DM may experience limited joint mobility due to glycation of joint structures, and hence flexibility training such as stretching activities are extremely essential for maintenance of full range of motion (ROM) of joints<sup>43</sup>. In addition to

that, daily stretching exercises may help in prevention and/or further delaying the development of progressive joint stiffness in the T2DM patients<sup>14</sup>. Since, in this study, aerobic exercise protocol consisting supervised walking with stretching exercises were introduced, those exercises may have strengthened the range of movement at the joints, and consequently more synovial fluid was released into the joints, which perhaps finally improved the level of mobility of the T2DM individuals. It might have also helped to improve the state of maintaining self-care and carrying out usual day-to-day activities as it was witnessed in the outcomes, since percentage of participants reporting “no problem” in those parameters also increased in the Bangladeshi participants. The study participants showed significant differences in the levels of self-care and anxiety in aerobic exercise group. These improvements may also be referred to the inclusion of warmup and cool down stretching exercises in the aerobic exercise group. As the muscle became more elongated, the stiffness of the muscle reduced, which in turn, may have reduced the perceived the feeling of pain in the T2DM individuals. Additionally, the feeling of being more flexible and comfortable in their own bodies may have helped them to reduce the perceived anxiety level. In addition to that, Visual Analogue Scale (VAS) of EuroQol-5D-5L (EQ-VAS) also illustrated an overall impression that, compared to control group (no intervention group), aerobic exercise intervention group had shown improvements in enhancing the health status of T2DM individuals after 14 weeks of supervised walking. Hence, it can be postulated that, after 14 weeks of aerobic intervention, improvements in the overall health status in T2DM individuals were observed. These results of the current study are corroborated by the findings of the study done by Myers et al. in 2013<sup>20</sup>. However, the post-intervention and follow-up assessments revealed that majority of the participants from aerobic intervention program, perceived slight increment in their perceived feelings of pain and discomfort. The probable reason for increasing pain level in aerobic exercise group could be due to muscle soreness resulted from exercise intervention. This phenomenon takes place when the muscle tissue is stressed beyond the extent of its habituation. But from the standpoint of exercise physiology, it should not be the case, as exercise-induced pain due to muscle soreness is not likely to happen even 14 weeks of aerobic exercise, since muscular adaptation to exercise-induced stress is supposed to be well-set by that time<sup>15</sup>. In the present study, for Bangladeshi participants, exercise-intensity was strictly monitored, so that the exercise-intensity never get irregular. Subjective self-report analysis was carried out in this present study, in which situation-specific index of feeling of pain/discomfort was evaluated by employing EuroQol<sup>11</sup>, which also has several limitations, since only single-item statement is specified to report on self-perception on feeling of either pain or discomfort (which are different terminology of virtually dissimilar health conditions). Thus, merely slight increment in perceived feeling of pain/discomfort reported by the participants in aerobic exercise group, cannot be considered as a crucial delimiting factor, since, increment in discomfort (for instance, displeasure; uneasiness; embarrassment; unpleasantness or upset) may be considered as analogous to pain, which may be resembled as ache; cramp; spasm; soreness; strain; throb or stitch. Hence, the observed slight increment in pain/discomfort as reported by the participants may be considered as their subjective bias in revealing their inner state of feeling accurately enough, through self-report indices. This could be the problems prevailing with the subjective self-reports, which are always susceptible to contain ‘response biases’<sup>16</sup>, and hence may be considered as having source of fallible data<sup>17</sup>.

The outcome of this study also showed that participants in the combined exercise group, the perceived level of mobility improved, as majority of the T2DM individuals, being introduced to combined exercise intervention reported to perceive ‘no problem’ in mobility. This outcome was corroborated by another study<sup>18</sup> where they affirmed that combined stretching and resistance training resulted in significant strength gains and improvement in the level of flexibility in T2DM population. As they proposed this might have happened, since T2DM individuals perhaps had to overcome more delicate and harmful effects of diabetes on joint mobility<sup>18</sup>. In this study, combined exercise protocol comprised of strengthening exercises along with supervised walking and (warm-up/pre-and post-exercise) stretching exercises were introduced. Those exercises were supposed to heighten the range of movement at the joints, and consequently more synovial fluid was released into the joints, which perhaps finally improved the level of mobility of the T2DM individuals, which is verified by earlier research<sup>19</sup>. Introduction of 14 weeks combined exercises in this set of population received support from the previous research of Herriott and colleagues (2004)<sup>18</sup>, who reported that, even 8 weeks of combined flexibility and resistance training had great beneficial impacts in enhancing the level of mobility and had also shown positive changes in self-care and carrying out usual activities. Apart from the observed improvements in mobility, characteristically significant differences were observed in the level of anxiety in the combined exercise group. Hence, it can be said that there were progresses in the overall health status in T2DM individuals after 14 weeks of combined intervention period.

Similarly, like aerobic exercise group, the post-intervention and follow-up assessments revealed that majority of the participants from combined intervention program perceived slight increment in their perceived feelings of pain and discomfort. Identical to this finding, increment in level of bodily pain at the post-intervention assessment was also observed in RCT carried out by Myers and colleagues (2013)<sup>20</sup>. As these researchers (2013)<sup>20</sup> opined, the probable reason for increasing pain level in combined exercise group in their study and in case of this study as well, could be due to muscle soreness resulted from different exercise interventions. But from the standpoint of exercise physiology, it should not be the case, as exercise-induced pain due to muscle soreness is not likely to happen even after 9 months of resistance training, since muscular adaptation to exercise-induced stress is supposed to be well-set by that time<sup>15</sup>. Hence this proposition of muscle soreness induced pain, cannot be considered as valid, unless the change in the exercise-intensity is awkwardly or abruptly introduced over 10% of usual training intensity<sup>15</sup>. In the present study, exercise-intensity was strictly monitored, so that the exercise-intensity never get irregular (optimal individual-specific care was taken to check exercise-intensity of all the exercised regimes introduced to the participants). In the RCT of Myers and colleagues (2013)<sup>20</sup> on the contrary, neither exercise-intensity nor the MET (metabolic equivalents) was evaluated, and hence they could not identify and regulate the possibility of over-training or burnt-out syndrome, whereas, any such possibility in this study was nullified by adequate individual-specific monitoring during and as well as before and after exercise intervention sessions were conducted.

In this research, middle-aged T2DM population have shown tremendous improvement in reducing the extent of problem in anxiety/ depression state among other health states, categorized by EQ 5D -5L after the exercise intervention session in aerobic and combined exercise groups. This improvement could be attributed to involvement in regular physical activity as in differential exercises with peer’s lead to “process benefits” for T2DM individuals<sup>21</sup>. These might transpire due to increase social interactions from group participation, improved self-esteem due to positive perception of own health or improved level of endorphin because of aerobic exercise.



In comparing the overall health status by the direct elicitation method of Visual Analogue Scale (VAS) of EuroQol-5D-5L (EQ-VAS), it has been observed that at the post intervention phase (after 14 weeks of intervention session), participants gave an overall impression that, combined exercise group had the highest improvement compared to aerobic exercise group at the post-intervention phase. However, no difference was observed between aerobic and combined group at the follow-up phase.

## 5. CONCLUSIONS & RECOMMENDATIONS

It can be concluded that participants in the aerobic and combined exercise intervention have shown improvement in overall perceived health status of T2DM individuals in Dhaka, Bangladesh. Moreover, combined exercise program had revealed the best outcome compared to aerobic and no exercise program. In the coming days, more interventional research could be carried out with larger sample including all seven divisions of Bangladesh with different income groups (low-income, middle income, high income) to have an overall scenario of the consequences of exercise interventions in improving perceived health status of T2DM population in Bangladesh. Along with that analysis can be done with health economic dimensions of the exercise interventions for the diabetic population in Bangladesh.

## 6. LIMITATIONS

In this research only 66 middle aged Type 2 Diabetic individuals who belonged to the middle-income group were included. In addition to that only people who were diagnosed as having T2DM for 7 -10 years were taken for this research. Further to that, participants were selected only from one division of Bangladesh due to logistical problems. Therefore, it would be difficult to conclude about the improvement in perceived health status for the entire Bangladeshi T2DM population.

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## 8. CONTRIBUTION OF AUTHORS

Conceived and designed the experiments: FaS, SS, SS, RM

Collected data and performed the experiments: FaS

Contributed with materials/analysis tools: FaS, SS, SS, RM

Analysed the data: FaS, SS

Wrote the manuscript: FaS

Checked and edited the format: FaS, SS

Final approval: FaS

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*Experimental Research: Bangladesh 50th year. Efficacy of exercise on improvement in health-status among Bangladeshi diabetic patients*



# COST-EFFECTIVENESS OF DIFFERENTIAL EXERCISE INTERVENTIONS IN IMPROVING PERCEIVED HEALTH STATUS OF BANGLADESHI DIABETIC INDIVIDUALS

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## KEYWORDS:

Type 2 Diabetes Mellitus, Aerobic exercise, Combined exercise EuroQol 5D-5L, Cost Effectiveness Analysis, Bangladesh

## ABSTRACT

**Background:** Type 2 diabetes mellitus (T2DM) poses huge health burden for individuals and societies. Currently, the brunt of high prevalence of T2DM in low- and middle-income countries (LMICs) are creating economic burden for the economies.

**Aim:** This study aims to assess the cost-effectiveness of differential exercise interventions directed to improve the perceived health status of T2DM individuals of Bangladesh.

**Method:** 66 middle-aged T2DM individuals residing in Dhaka, Bangladesh from middle-income strata of the society were included. EuroQol 5D-5L questionnaire was used for the evaluation of perceived health-status. There was 14 weeks of intervention sessions carried out to assess the cost-effectiveness of the differential exercise programs. In this study, the provider's perspective was taken for cost-effectiveness analysis. Incremental cost effectiveness ratio (ICER) was designed and calculated to assess the cost - effective exercise program for the T2DM population.

**Results:** In terms of total costs from provider's perspective, combined exercise intervention program had the lowest ICER value with highest improvement in health status and highest cost. Besides, EQ-VAS score measuring improvement in health status of middle-aged T2DM individuals was highest in the combined exercise program (EQ-VAS score = 91.60) compared with aerobic training (EQ-VAS score = 86.05) and no exercise program (EQ-VAS score = 81.00) after the intervention sessions.

**Conclusions:** Combined exercise program was evident as the most cost-effective programme among aerobic and no exercise programme for T2DM participants residing in Dhaka, Bangladesh.

## 1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) considerably adds to the prevailing crises associated with preventable diseases and leads to economic losses that arise from high health-care cost and loss of productivity<sup>1</sup>. Generally, there would be two types of costs to be considered while measuring the costs of a disease like T2DM<sup>2</sup>. First, there exists a direct cost which refers to the immediate costs a person has to bear in terms of the money needed to buy medical services, drugs, and other supplies to get better or keep the condition under control. It can also be considered the financial costs borne by national healthcare systems. On the other side, the second type of cost is indirect cost which refers to the costs of productivity losses due to taking time off from work for sickness or attendance for health care; inability to work because of disability (for example - impairment of vision); premature retirement because of disability; premature mortality because of the acute or chronic complications and others<sup>3</sup>.

In the United States alone, the direct medical cost of diabetes amounts to US\$92 billion annually, with indirect costs adding another US\$40 billion<sup>4</sup>. In Italy, the cost of T2DM was estimated at US\$58 billion, amounting to more than 6% of total private and public healthcare expenditure<sup>5</sup>. T2DM also causes a substantial economic burden in lower-income economies. For example, in the Caribbean and Latin America, the total annual cost associated with diabetes may be around US\$65 billion<sup>6</sup>. In developing countries, a large number of people are living on or beneath the poverty line and face problems in accessing health care services. Along with that, these countries also face lack of national welfare schemes and provision of health insurance for the poor population. The underprivileged people cannot afford to pay for healthcare services. Hence, they are diagnosed late with diabetes, resulting in acute and chronic complications<sup>7</sup>. Once considered to be a disease of wealthy nations, T2DM now constitutes a truly global affliction. International Diabetes Federation (IDF) anticipates that the worldwide incidence of diabetes among those aged 20 to 79 years

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will increase by around 70% in the next 20 years<sup>8</sup>. The increase will affect all global regions, with projected increases ranging from 21% in Europe to 11% in Africa. Regarding Southeast Asia, it will see an additional 40 million cases of T2DM by 2025<sup>8</sup>. In addition to that, cost per person with diabetes in Malaysia was calculated to be US\$ 565.8 in 2015<sup>9</sup> which does put a lot of pressure on the economy of Malaysia. Likewise, the prevalence of T2DM and its adverse health effects have risen more rapidly in South Asia<sup>3</sup> and in Bangladesh, the cost per person with diabetes was US\$ 42 in 2015<sup>9</sup>, which does lead the country into to a huge economic burden.

T2DM requires constant medical care, patient self-care and education to prevent various complications and to reduce the risk of long-term diseases to maintain a healthy lifestyle<sup>10</sup>. According to Australian Institute of Health and Welfare (AIHW)<sup>11</sup>, health status is an inclusive concept which is verified by more than the existence or absence of any kind of disease. It is often summarised by self-assessed health status or life expectancy or/and in a broader sense also include physiological and psychological measurements. Over the last few decades, extensive effort has been given in developing health-status measurement tools to analyse various results in public-health and clinical research<sup>12</sup>. Health and wellness evaluative index, such as EuroQol 5D-5L (EQ 5D-5L)<sup>13,14</sup> and others were extensively utilised to measure the perceived health status of the T2DM population.

Costs are seen in different ways from different point of views. In economics, the idea of cost is built on the value which can be gained from exhausting resources somewhere else – stated as the opportunity cost. Therefore, it means, the resources which are used in a program cannot be used in another program and, therefore, the profits that could have been received have been forgone<sup>2</sup>. It is common, in practice, to take the price paid as the opportunity cost, and to embrace a practical method to costing and use market prices wherever possible. In cost-effectiveness analysis it is conventional to distinguish between the direct costs (e.g. Medical costs - drugs, staff time, equipment, Patient costs – transport, out of pocket expenses) and indirect or productivity costs (e.g. production losses, other uses of time) associated with the intervention, as well as what are termed intangibles (e.g. pain, suffering, adverse effects), which, even though can be challenging to quantify, are often consequences of the intervention and should be incorporated in the cost profile<sup>2</sup>.

However, it is crucial to specify which costs are incorporated in a cost-effectiveness analysis (CEA) and which are not, to make sure that the findings are not subject to misinterpretation. The central function of CEA is to illustrate the comparative value of alternative interventions for the betterment of health status. CEA analysis can provide information that can help decision makers and individuals in a variety of settings to weigh alternatives and decide which best serve their programmatic needs<sup>15</sup>.

In the present scenario, very few researchers have adopted CEA to inform decisions maker about health services in developing countries although T2DM in developing countries have certainly emerged as a major public health problem. Besides, in the case of developing countries like Bangladesh, complications from diabetes can be devastating<sup>16,17</sup>. Moreover, it has been seen that the incremental costs of an individual with T2DM arise not only when the diagnosis is done but at least 8 years earlier<sup>18</sup>. Hence, the medical and socioeconomic burden of this disease imposes enormous strains on health care systems. Therefore, this study tried to assess the cost effectiveness of the aerobic and combined exercise training programs to help the health

care authorities to strategize an authentic, economical yet less time-consuming package of exercise intervention techniques, intended for reduction in metabolic distress and life-threatening crises towards realistic management of economic resources for T2DM population in Dhaka, Bangladesh.

## 2. METHODOLOGY

Cost effectiveness analysis was carried out to determine the differential impacts of exercise interventions (aerobic and combined exercise program) evidenced among middle aged individuals with T2DM living in Dhaka, Bangladesh. Ethical approval for this study was obtained from the Bangladesh Institute of Sports Science (Ref.no.BISS/ACEC/0104). The standardised inclusion and exclusion criteria (Sultana et al., 2018) were used to select participants for the study. Participants were invited from the outpatient department (OPD) of the Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorder (BIRDEM) General Hospital to participate in the study. After the baseline assessment, selected 75 participants were randomly categorized (following concealed allocation) into three groups. Group A: Control group (N = 25, received no intervention); Group B: Experimental Group I (N = 25, received aerobic exercise training i.e. walking) and Group C: Experimental Group II (N = 25, received combined exercise, i.e. aerobic exercise training and resistance/strengthening exercise training). At last, out of 75 participants, 66 participants continued the intervention sessions. The detail intervention technique for the exercise programs could be found in Sultana et al., 2018<sup>19</sup>.

Firstly, the costs for this study were identified through thorough assessment. Then those costs were measured and adjusted accordingly. The perspective adopted in this research was mainly the provider's perspective which usually refers to the inclusion of only direct costs of setting up and running a programme. In addition to that, medication costs of the participants were also included. In this analysis, we focused on the intervention phase of the program and excluded any costs that dealt with intervention development, assessment and data collection and any other research-related activities that would not need to be included if this aerobic or combined exercise program is considered to replicate or implement in real world setting.

In this research, participant's costs consisted of pharmaceutical drugs which were mainly oral anti-diabetic drugs and insulin injection for the T2DM population. In addition to that the interventional costs consisted of costs of facilitators, costs of expert, utility and administration cost, cost of venue and cost of activity equipment. In case of the control group only costs of pharmaceutical drugs were included. On the other hand, the aerobic and combined exercise group incurred medication costs with costs of facilitators, costs of expert, utility and administration cost, cost of venue and cost of activity equipment. All capital costs, such as cost of procurement and maintenance of the equipment were discounted at 3% annually<sup>20</sup>.

The unit of health in this study has been measured as the health status illustration, that is, change in health status resulting from the differential exercise interventions by the direct elicitation method of Visual Analogue Scale (VAS) of EuroQol-5D-5L(EQ-5D-5L). In that scale, the possibility of being in best health denotes '100' points and the possibility of being in worst health denotes '0' point. A respondent can choose any point among 0 to 100 on the EQ VAS scale based on his/her understanding of the health status.

The cost model in this research is simple accounting of costs over a short period of time, so no models of asset depreciation were necessary. Besides, the health outcome (EQ-VAS) was taken from randomized controlled trial, so no synthesis of diverse epidemiologic and clinical studies required to be modelled. In this research, incremental cost-effectiveness ratios (ICERs) were used.

ICER compared the differences between the costs and health outcomes of two alternative exercise interventions versus no exercise intervention that competed for the same resources, thus it could be interpreted as additional costs per unit health outcome. ICER for aerobic exercise group was calculated as:

$$(CB - CA) / (EB - EA)^{15}$$

Where,

CB = Cost of Intervention Group B (Aerobic Exercise group),

CA = Cost of Intervention Group A (Control group)

EB = Effectiveness of Intervention Group B (Aerobic Group)

EA = Effectiveness of Intervention Group A (Control group)

ICER for combined exercise group was calculated as:

$$(CC - CB) / (EC - EB)$$

Where,

CC = Cost of Intervention Group C (Combined Exercise group)

CB = Cost of Intervention Group B (Aerobic Exercise group)

EC = Effectiveness of Intervention Group C (Combined group)

EB = Effectiveness of Intervention Group B (Aerobic group)

Statistical Package for the Social Sciences (SPSS) version 23.0 was used for analysing the data.

### 3. RESULTS

In this study, participants had a mean age range of 55 years ( $54.90 \pm 4.18$ ). There were 21 males (31.8%) and 45 females (68.2%). The average duration of participants was 8 years ( $8.00 \pm 1.16$ ) with mean HbA1c level of 9.85 %. Alongside, the average income of the participants was BDT 28066.67 (Table 1).

In terms of the cost calculations, the direct costs were consisted of pharmaceutical drugs which were mainly oral anti-diabetic drugs (Metformin HCl 500 mg and Glimepiride 2 mg tablet) and insulin injection (Insulin Lispro 100 IU/ml injection in prefilled syringe/cartridge- 3 ml cartridge) and interventional costs. In the control group where participants were only following the proscribed medications had only the costs of pharmaceutical drugs under the purview of costing. On the other hand, aerobic exercise and combined exercise groups incurred various interventional costs along with medication costs. Regarding interventional costs there were costs of facilitators, costs of expert, utility and administration cost, cost of venue and cost of activity equipment (Table 2).

The table 2 depicts the total cost of T2DM participants per annum in different intervention groups (aerobic exercise and combined exercise) and in no intervention group (control group). All the costs were calculated for per annum for the convenience, though this research has been done for 28 weeks. Anti-diabetic medication costs were for round the year that is for 365 days per annum. The interventional costs were for 52 weeks per year (for first 6 weeks\* 3 days per week = 18 days and for the rest 46 weeks \* 4 days a week = 184 days) as per the intervention protocol. Hence, total 202 days per annum in interventional session for both aerobic and combined group participants. A facilitator was appointed for each group to come every day of intervention session (202 days) to administer the intervention sessions but an expert was appointed to come once in a week (52 days) to supervise the exercise interventions.

**Table 1**  
*Socio-Demographic data of the participants*

Variables	Overall N=66	Control (No Exercise) Group n=22	Aerobic Exercise Group n=24	Combined Exercise Group n=20
	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD	Number (%) Mean $\pm$ SD
Gender				
Male	21 (31.8)	5 (22.7)	8 (35.3)	8(40)
Female	45 (68.2)	17 (77.3)	16 (66.7)	12 (60)
Age (Years)	$54.90 \pm 4.18$	$53.15 \pm 4.90$	$54.75 \pm 3.31$	$56.80 \pm 3.49$
Diabetic year (Years)	$8.00 \pm 1.16$	$8.10 \pm 1.25$	$7.80 \pm 1.06$	$8.10 \pm 1.21$
HbA1c (m.mol/l)	$9.85 \pm 1.64$	$9.95 \pm 1.73$	$9.84 \pm 1.54$	$9.76 \pm 1.73$
Monthly Income (BDT)	$28066.67 \pm 7506.53$	$27880.00 \pm 8327.10$	$27880.00 \pm 7586.25$	$28440.00 \pm 6918.35$

**Table 2**  
*Total Cost of Participants in different groups*

Item (Cost per person)	Control Group	Aerobic Exercise Group	Combined Exercise Group
a) Cost of Anti Diabetic Medication per annum per person (BDT):	23815.80	23815.80	23815.80
Cost of Activity per annum per person (BDT):			
b) Cost of Expert	-	7283.27	7283.27
c) Cost of Facilitator	-	12125.45	12125.45
d) Utility Cost	-	404.18	404.18
e) Pedometer	-	1499.95	1499.95
f) Polar Heart Rate	-	4600.07	4600.07
g) Sphygmomanometer	-	300.13	300.13
h) Walking Shoes	-	1000.08	1000.08
i) Theraband	-	-	1199.99
<b>Total Cost per annum per group:</b>	23815.80	51028.95	52228.95

Source: Directorate General of Drug Administration, Ministry of Health and Family Welfare, Bangladesh



Breakdown of the calculations of the aforementioned costs are as follows:

- Cost of Anti diabetic Medication per annum: Insulin Lispro 100 IU/ml injection in prefilled syringe/cartridge- 3 ml cartridge – BDT 2749.42 per box of 5 cartridges; BDT 550 per 3 ml cartridge; Metformin HCl 500 mg – BDT 2.00 and Glimepiride 2 mg – BDT 0.5
- Cost of Expert: Expert fees per day = BDT 3500  
One Expert was appointed for 25 participants. Per day cost/per person for Expert = BDT (3500/25) = BDT 140; Expert was appointed to come once in a week.
- Cost of Facilitator: Facilitator fees per day = BDT 1500  
One Facilitator was appointed for 25 participants. Per day cost/per person for Facilitator = BDT (1500/25) = BDT 60. Facilitator was appointed to come every day of intervention session.
- Utility Cost (Venue/Space Rent, electricity, water, service charge) per day = BDT 50.02  
Per day cost/per person for Utility charge = BDT (50.02/25 participants) = BDT 2.00 (intervention and assessment days)
- Pedometer per person BDT 1500 (discounted at 3%)
- Polar Heart Rate Monitor per person BDT 4600 (discounted at 3%)

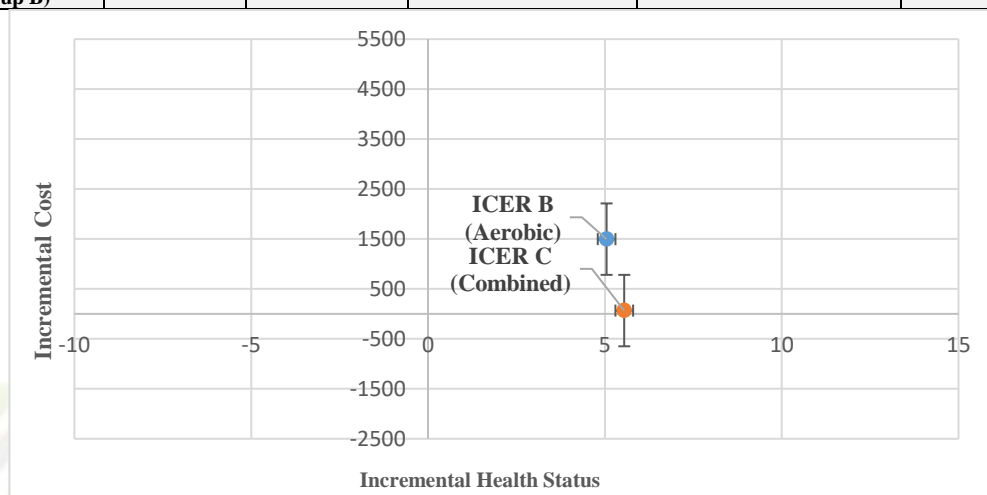
- Sphygmomanometer BDT 7500/25participants – per person BDT 3750 (discounted at 3%)
- Walking Shoes per person BDT 1000
- TheraBand – 3 different coloured TheraBand per person - BDT 400\*3=1200(discounted at 3%)

After calculating the costs incurred in different groups, it can be seen that total cost per annum per person in control group (no exercise intervention) was BDT 23815.80; aerobic exercise group was a total of BDT 51028.95 and combined exercise group was a total of BDT 52228.95 annually in Dhaka, Bangladesh. Hence, combined exercise group had the highest cost per person among the other groups.

The table below (table 3) shows the ranking of the different exercise intervention programs based on the ICER values from lowest to highest. The exercise intervention program which incurred lowest ICER value was ranked first in the table and followed accordingly. Here, it can be seen that combined exercise intervention program had the lowest ICER of positive BDT 216.22/Health Status. After that the ICER value of aerobic exercise intervention program was BDT 5388.74/Health Status among T2DM participants (Table 3).

**Table 3**  
**Ranking of Incremental Cost Effectiveness Ratio (ICER) (lowest to highest value)**

Intervention	Net Cost (BDT)	Incremental Cost ( $\Delta$ Cost)	EQ-VAS Score (Health Status –HO)	Incremental EQ-VAS Score (Health status– $\Delta$ HO)	ICER ( $\Delta$ Cost / $\Delta$ HO) (BDT)
1.Control (no exercise) (Group A)	23815.80	n/a	81.00	n/a	-
2. Combined Exercise program (Group C)	52228.95	1200	91.60	5.55	216.22
3. Aerobic Exercise program (Group B)	51028.95	27213.15	86.05	5.05	5388.74



**Figure 1**

**Cost-Effectiveness Plane (CEP) with mean ICER values for aerobic & combined exercise program**

Figure 1 demonstrates the mean ICER values for aerobic exercise intervention program (ICER B) and combined exercise intervention program (ICER C). It can be seen that mean of ICER of aerobic exercise intervention program (ICER B) and the mean of ICER of combined exercise intervention program (ICER C) both fell in the north-east quadrant in the north-east quadrant of CE plane stating that both the intervention programs were more effective and costlier compared to no exercise group (control group) in Bangladesh.

In addition, the mean ICER of combined exercise group (ICER C) positioned itself much lower than the mean ICER of aerobic exercise group (ICER B) in the north-east quadrant of CE plane. The combined exercise is more cost effective.

#### 4. DISCUSSION

The health outcome measure that was used in CEA in this research was the direct elicitation method of Visual Analogue Scale (VAS) of EuroQol-5D-5L (EQ-VAS).

The result gave an overall impression that both aerobic and combined exercise intervention group had shown improvements compared to control group (no intervention group) in enhancing the health status of T2DM individuals. At the post-intervention phase (after 14 weeks of intervention session), combined group showed the best outcome in improving the health status of the T2DM population.

In terms of total costs from provider's perspective, the combined exercise program was the most expensive (BDT 52228.95), followed by the aerobic exercise program (BDT 51028.95) and no exercise program (only medication cost) (BDT 23815.80) in Bangladesh. Besides, EQ-VAS score measuring improvement in health status of middle-aged T2DM individuals was highest in the combined exercise program (EQ-VAS score = 91.60) compared with aerobic training (EQ-VAS score = 86.05) and no exercise program (EQ-VAS score = 81.00) after the intervention sessions.

Now, the outcome of the CEA for T2DM population showed that for each additional percent improvement in health status of a Bangladeshi T2DM participant, additional cost of BDT 5388.74 can be invested to adopt aerobic exercise training program along with medication to manage diabetes instead of no exercise program in Bangladesh. The ICER for health status in combined exercise (supervised working and resistance exercises) group, on the other hand, denoted that for each additional percent improvement in health status of a Bangladeshi T2DM participant, additional cost of BDT 216.22 can be invested to adopt combined exercise training program along with medication to manage diabetes instead of taking on aerobic exercise training only. Therefore, combined exercise intervention program had the lowest ICER value with highest improvement in health status and highest cost. This has happened because the incremental health status score for combined group was higher than aerobic group. As a result, the higher cost of combined exercise program was saturated by the higher rate of improvement in health status over the time. Hence, for T2DM population combined exercise program was the most cost-effective compared to other alternative.

From the analysis, it has been observed that aerobic and combined exercise intervention has shown improvement in overall perceived health status of T2DM individuals measured by EQ-VAS in Dhaka, Bangladesh. Moreover, combined exercise program had shown the best outcome compared to aerobic and no exercise program. It is very important to mention that the presentation of health economic analysis is often restricted to some degree due to absence of recognized and acceptable threshold value for evaluating cost-effectiveness of a program. Under the purview of this research, we did not adopt any threshold level as no previous studies have registered a formal or informal threshold value for study population in Dhaka, Bangladesh. So, it would be even more informative to see if combined exercise program is cost-effective subject to decision maker's willingness to pay in future endeavours. This outcome was supported by couple of other studies done to measure the cost-effectiveness of exercise interventions in T2DM population in Canada<sup>21</sup> and Malaysia<sup>22</sup>. Those studies have explicitly shown that the combined exercise program remained cost-effective for all consequences considered and exercise interventions for T2DM individuals can be considered an efficient use of resources by the healthcare ministry. There was another relatively small-scale study related to endurance training for T2DM population in France on healthcare cost, body composition and fitness showed substantial reduction healthcare costs with exercise<sup>23</sup>. However, this study lacked proper cost-effectiveness analysis based on incremental cost-effectiveness in ratio. Apart from these few studies, no other study could not have been found where researchers have formally evaluated cost-effectiveness of differential exercise

interventions in assessing improvement in health status for middle-aged T2DM population. Besides a study by Mash et al.<sup>24</sup> have performed a structured group education program by mid-level trained healthcare workers at community health centers in the Western Cape, South Africa and have found the intervention to be cost-effective for T2DM population by sustaining a reduction in blood pressure. Besides, based on the assumption that the costs would recur every year and the effect could be maintained, was 1862 \$/QALY gained.<sup>24</sup> Another study by Gillet et al.<sup>25</sup> undertook a cost-utility analysis with diabetes education and self management intervention program and reported that it is likely to be cost effective compared with usual care, especially with respect to the real world cost of the intervention to primary care trusts, with reductions in weight and smoking being the main benefits delivered. Further to that, Ramachandran et al.<sup>25</sup> reported that lifestyle modification and metformin were cost-effective interventions for preventing diabetes among high risk-individuals in India and perhaps may be useful in other developing countries as well. However, the long-term cost-effectiveness of the interventions needs to be assessed. Besides, there were few more studies found measuring cost-effectiveness of lifestyle modification programs where exercise was a part for pre-diabetic or diabetic population<sup>26,27</sup>.

It is important to mention that there can be few limitations in conducting health economic analysis in chronic diseases based on experimental set ups or clinical trials because of short duration of the system. In this research, 14 weeks health outcomes were considered which might have the possibility of not sustaining over a long period of time; even though uncertainty analysis was incorporated to control and check the stability of the results for 52 weeks (one year) outcomes. However, examining 52 weeks outcomes may have fading out effect of the original differences between differential exercise programs and no exercise program because study population were not under direct supervision for the rest of the period. Nonetheless, there can be concerns of the improvements observed even after uncertainty analysis, although this analysis assumes that continued involvement of exercise specialist and facilitators would be funded for the entire duration of the exercise programs. Therefore, there is always a possibility of losing out the perceived improvements obtained from experimental set up due to limited duration from any exercise intervention. There was previous literature done where it has been seen that different exercise intervention did not improve the overall perceived health status of T2DM individuals<sup>28</sup>. That is why this study did not consider any additional clinical or health benefits coming from exercises in T2DM participants or did it consider and additional costs to participants like lost time to carry out other activities. Eventually, in the real set up, usually individuals choose to continue their exercise program based on an assessment of the comparative health benefits versus costs incurred.

Lastly, CEA that has been done in this research can be taken as highly conservative because it assumes no additional health improvements beyond the study period whereas continued costs of exercise programs were included for 52 weeks. This is because the health improvements were seen just for 14 weeks (intervention period) and the improvements could not be predicted for the rest of the period given the uncertainties of health status unlike program costs. Despite all these assumptions and limitations, the CEA analysis still can recommend that combined exercise intervention program can be cost-effective for healthcare authorities to handle the health and economic burden of T2DM in Dhaka, Bangladesh.

## 5. CONCLUSIONS & RECOMMENDATIONS

Outcomes of this experiment revealed that, combined exercise program was evident as the most cost-effective programme among aerobic and no exercise programme for T2DM participants residing in Dhaka, Bangladesh. Future studies could be done with multicentre approach, larger and heterogeneous population, including other regions and rural-urban set-ups of Bangladesh. In addition to that, comparison between different experimental set-ups could also be carried out, especially to verify subject-relevant, culture-relevant and



situation-relevant issues that may affect the overall perceived health-status of T2DM population.

## 6. LIMITATIONS

Every study does have a few intrinsic limitations. Similarly, this research also had certain limitations. Only provider's perspective for cost-effectiveness has been looked into. Only 66 participants from Dhaka, Bangladesh was included in this study, instead of choosing more places due to logistical problems. Moreover, T2DM participants with other chronic comorbidities diseases were excluded. Hence, it would be incomprehensible to conclude about the cost-effectiveness of differential exercise interventions in improving perceived health status of entire Bangladeshi Type 2 diabetes individuals.

## 7. ACKNOWLEDGEMENT

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## 8. CONTRIBUTION OF AUTHORS

Conceived and designed the experiments: FaS, RM, SS, SS

Collected data and performed the experiments: FaS

Contributed with materials/analysis tools: FaS, RM, SS, SS

Analysed the data: FaS, SS, RM

Wrote the manuscript: FaS

Checked and edited the format: FaS, SS

Final approval: FaS

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## Process of Acceptance for SECTION II articles (Articles on Health Science)


Article ID	Reviewer	Affiliation	Assigned as	Decision
<b>MS-BD50-Res-Exp. Health Sc - 1</b>	Associate Prof. Dr. Santanu Dutta	Associate Professor, Dept. of CTVS, Inst. of PG Medical Education and Research Kolkata, India	First reviewer on <b>March 26<sup>th</sup> 2021</b>	Accepted after major Change
	Dr. Mohammed Faruque Reza	Senior Lecturer, Neurosciences Universiti Sains Malaysia Malaysia	Second reviewer on <b>May 1<sup>st</sup> 2021</b>	Accepted with moderate level of revision
	Associate Prof. Dr. Anish Kr. Mukhopadhyay	Associate Professor Economics, West Bengal State University, India	Final reviewer on <b>May 23<sup>rd</sup> 2021</b>	Accepted for publication on <b>27<sup>th</sup> August 2021</b>

Article ID	Reviewer	Affiliation	Assigned as	Decision
<b>MS-BD50-Res-Exp. Health Sc - 2</b>	Associate Prof. Dr. Nasrin Wadud	Associate Professor, Dept. of Psychology, Dhaka University, Dhaka, Bangladesh	First reviewer on <b>March 30<sup>th</sup> 2021</b>	Accepted after major Change
	Dr. Abhisha Bhattacharya	State Aided College Teacher Education Savitri Girls' College, Calcutta University, India	Second reviewer on <b>April 6<sup>th</sup> 2021</b>	Accepted after major Change
	Prof. Dr Anang Kistyanto	Dean, Faculty of Economics State University of Surabaya Surabaya, Indonesia	Final reviewer on <b>May 3<sup>rd</sup> 2021</b>	Accepted for publication on <b>30<sup>th</sup> August 2021</b>

Article ID	Reviewer	Affiliation	Assigned as	Decision
<b>MS-BD50-Res-Exp. Health Sc - 3</b>	Associate Prof. Dr. Santanu Dutta	Associate Professor, Dept. of CTVS, Inst. of PG Medical Education and Research Kolkata, India	First reviewer on <b>March 29<sup>th</sup> 2021</b>	Accepted with moderate level of revision
	Dr. Mohammed Faruque Reza	Senior Lecturer, Neurosciences Universiti Sains Malaysia Malaysia	Second reviewer on <b>May 1<sup>st</sup> 2021</b>	Accepted after minor Change
	Associate Prof. Dr. Anish Kr. Mukhopadhyay	Associate Professor Economics, West Bengal State University, India	Final reviewer on <b>May 19<sup>th</sup> 2021</b>	Accepted for publication on <b>25<sup>th</sup> August 2021</b>

Article ID	Reviewer	Affiliation	Assigned as	Decision
<b>MS-BD50-Res-Exp. Health Sc - 4</b>	Dr. Mohammed Faruque Reza	Senior Lecturer, Neurosciences Universiti Sains Malaysia Malaysia	First reviewer on <b>May 1<sup>st</sup> 2021</b>	Accepted with minor change
	Prof. Dr Sujar Wanto	Vice Rector, Planning and Partnership, State University of Surabaya, Surabaya, Indonesia	Second reviewer on <b>May 5<sup>th</sup> 2021</b>	Accepted with moderate level of revision
	Prof. Dr Anang Kistyanto	Dean, Faculty of Economics State University of Surabaya Surabaya, Indonesia	Final reviewer on <b>May 25<sup>th</sup> 2021</b>	Accepted for publication on <b>28<sup>th</sup> August 2021</b>

## Finalised by the Guest Editors

Name of the Section Guest Editors	Affiliation of the Section Guest Editors	E- Signature of the Section Guest Editors
Prof. Dr. Hairul Anuar Hashim	Deputy Dean (Research) and Professor, Exercise & Sports Science, Universiti Sains Malaysia, Health Campus, Kota Bharu, Kelantan, Malaysia	
Prof. Dr. Asok Ghosh	Professor, Faculty of Sports Science, RKMV University, Kolkata, West Bengal, India	