A Structural Equation Model for Education, Mental Health, and Nutrition for Young Egyptians

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Abstract

Modeling and analyzing critical issues such as the educational achievement, the mental health and the nutritional behavior of young people may result in important implications. The current study investigates a simultaneous relationship involving the three main variables, with a new extended theoretical framework based on the univariate results from previous empirical studies from the many relevant disciplines. The study also explores whether the mental health is a moderator for the relationship between the two other variables. Up to the knowledge of the researcher, these hypothesized ideas have not been investigated before. The model carrying the hypotheses, which is named by the researcher the "E-M-N Moderation Model", is analyzed using the structural equation modeling technique (SEM), after the needed statistical manipulations and tests and treatements for all the statistical assumptions. The results show that, based on the available data from the survey of young people in Egypt (SYPE-2009), the specified "E-M-N Moderation Model" is an acceptable fit. But the hypotheses of simultaneous-moderation don't seem to be true in Egypt. The researcher argues that this doesn't necessarily imply that the hypothesized idea is not true and must be absolutely rejected, and several arguments are presented to show that this result is most probably due to the critical limitations of the study. Therfore, it is recommended that the idea and the model be tested on other datasets using special surveys avoiding the possible limitations.

1. Introduction

A statistical model is a set of assumptions about the data-generating process for a particular system of interest. The model provides a vehicle for testing the idea ruling these assumptions. This idea is based on a particular theory or results of previous empirical studies (Kline, 2015).

The young people (adolescents & youth) are the major human resource in a country. Modeling and analyzing critical issues related to their quality of life may results in important implications for the public policy, the theory, and the daily life of the young people.

The education, the mental health and the nutrition of young people are some of these critical issues that affect the quality of their lives, and hence affect their countries. Globally speaking, quality education, quality health care (physical & mental) and improved nutrition are known as a basic human right. This right is highlighted in the goals # 2, 3 and 4 of the "United Nations Sustainable Development Goals (SDGs)" which has replaced and is building on the "Millennium Development Goals (MDG's) (UN General Assembly, 2015).

When studying education, most of the previous studies have focused on the quantity of education, measured by the number of years in education, education attainment, education dropouts, and education enrollment. Fewer studies have tackled the quality of education measured by the educational achievement, which is reflected by test scores or final GPA. The education quality is the focus of the current study.

As for the mental health, there are two definitions in the literature; the "negative definition" which is about the presence or absence of a mental disorder, and the "positive definition" which is about the psychological well-being even though no mental disorder is present. The focus of this study is on the negative definition of mental health, namely the depression disorder and the anxiety disorder.

Concerning the nutrition, the majority of the previous researches have studied the nutritional status measured by the stunting, the wasting and/or the body mass index (BMI). Some studies have focused on the nutrients intake (macro and/or micro nutrients). Fewer studies have investigated the nutrition measured by the intake of the food from the main food groups. This latter form of nutrition is the focus of the current research.

Of those studies interested in the educational achievement, or the nutritional behavior (food intake) or the mental health (negative definition), many theoretical and empirical ones have investigated the possible determinants of each of these variables.

Several studies have investigated the short-term effect of the nutritional behavior (food or nutrients intake) on the education's measures, and some of them have shown some statistical evidence about a positive effect.

Also, several researches have studied the effect of mental health (negative definition) on the educational outcomes, and some of them have given some statistical evidence about a negative effect of the presence of a mental disorder.

Up to the best of the knowledge of the researcher, the relationship between the three variables all together has not yet been investigated, because of its multi-disciplinary nature. This probable simultaneous relationship is the goal of the current paper.

The research is based on the data from SYPE-2009, a survey conducted on a nation-wide representative sample from the Egyptian young people.

The hypotheses to be tested in the current study are the following:

1) a) There exists a significant positive relationship between the dependent endogenous variable "educational achievement" of the students in the target populations and the independent endogenous variable their "short-term nutritional behavior".

b) There exists a significant negative relationship between the dependent endogenous variable their "educational achievement" and the independent endogenous variable their "mental health status" (the presence of a mental disorder).

2) This relationship between the three main variables can be modeled as a system of three simultaneous equations.

3) The mental health variable is a moderator for the relationship between the educational achievement and the nutritional behavior for the students in the target populations.

The main objectives of the study are:

1) To test the study's hypotheses, using a suitable statistical technique.

2) To specify the determinants of each of the 3 variables based on the new data from Egypt.

3) To highlight the implications of the study's results, concerning the theories related to the main variables, the future research, the public policy, and the whole society.

2. Review of Literature

Since the study is multidisciplinary, the review is divided into five subsections.

2.1 Education Determinants

When studying the education's determinants there are several theoretical schools of thought:

- The econometric point of view: studies such as (Glewwe, 2002, 2005; Hanushek, 1995), see the education equation as a "production function" where the parents invest their effort, money and more in their children, besides the role of the innate ability of the child, the child's health status, and the school and teacher characteristics.

- The sociological studies such as (Condron, 2009; Downey et al., 2004; Downey et al., 2008) are interested in the influences from the society and from the family.

- The psychological studies such as (Gorard et al., 2012; Green et al., 2006; Parkerson et al., 1984), focus on the cognitive factors and the affectionate factors of the student.

In addition to that: the "Carroll Model" (Carroll, 1963, 1989) focuses on the quantity and quality of the time for studying. The "Walberg Model" (Walberg, 1981) concentrates on the student's ability and motivation, and the quality and quantity of instruction. The "Unified Learning Model" (Shell et al., 2010) sees that the working memory, the knowledge and the motivation of the student are the main determinants of the educational achievement.

Many empirical and review-type studies have investigated the determinants of the education measures whether worldwide or in the African, Arab, or MENA (Middle East & North African) countries including Egypt. Reynolds and Walberg (1992) found that prior achievement, home environment, exposure to mass media through reading, and instructional time have significant effects on educational achievement. Roeser and Peck (2003) clarify that the socio-economic circumstances, the school quality, the support from the family and friends, and the student's scholastic aptitude are important factors for the educational achievement. Brooks (2014) highlights that student's wellbeing and life satisfaction, student's social and emotional skills, the quality of teaching, the school environment, and the student's physical activity, all have important effects on the educational achievement. Lawrence (2015) clarifies that among the factors affecting the educational achievement are: the student's innate ability, cognitive, behavioral, social and emotional skills, the family structure, socio-economic status, attitude toward education, educational expectations toward their children, and the school and community characteristics.

Some empirical and review-type studies such as Ridker (1997) highlight that child, household, school and community characteristics all have important effects on the educational achievement. Lloyd et al. (2001) found an association between the school quality and the educational attainment. Salem (2004) concluded that there is an association between adolescent's educational attainment and both the number of siblings and the individual's ordinal position in the sibling group.

Badr (2012) concluded that the home background (e.g., mother and father education) and the student characteristics effects on the educational outcomes are higher than the school quality and the teacher characteristics variables. Assaad et al. (2014) found that the student's gender, the mother and father education, the rural/urban residence and the wealth quintile, all have significant effects on the educational attainment.

This review of literature covers about 100 determinants of the educational achievement. The available data about Egypt has allowed for 39 determinants of them (whether directly from the survey or by creating some new variables from the available survey data), in addition to the other two basic variables, as shown in **Figure 1**.

2.2 Mental Health Determinants

When studying the mental health determinants there are mainly five theoretical schools of thought (Approaches of Psychology) (Glassman et al., 2008; Jarvis, 2005; McLeod, 2007): **1)** The Psychodynamic approach is interested in the past experiences and life events of the person through his life since his childhood. **2)** The Biological / Evolutionary approach sees that the heredity, the genes and the brain chemicals shape the person's mental health status. **3)** The Behavioral approach focuses on the environmental determinants. **4)** The Cognitive approach values the brain's cognitive abilities and power of thinking as determinants of the person's mental health. **5)** Finally, the Humanistic approach focus on the person's self-image as a determinant of his mental health status.

Many empirical and review-type studies have investigated the determinants of the mental health whether worldwide or in the African, Arab, or MENA countries including Egypt. Dwairy and Menshar (2006) found that the parenting style (authoritative vs. authoritarian) has a significant effect on the adolescents' mental health. Jané-Llopis and Braddick (2008) highlight that parental support,

prior academic achievement, adolescent's abuse or domestic violence, poverty, discrimination, parental smocking, and parental divorce, all have high effects on the mental health of young people. Wahlbeck and Mäkinen (2008) marked the importance of the previously mentioned factors in addition to the effects of the negative life events and of the deprivation on the youth's mental health. Davidson and Locke (2010) pointed out the important effects of the stressful life events and work stress, the personal loss, the academic failure, the loneliness, and the individual's good self-characteristics as determinants of the youth's mental health. Fisher et al. (2011) marked the important effect of the excessively high parental expectations of their children's academic success, and the adolescent's exposure to violence whether at home or at school. Johnston et al. (2014) found that the family history of mental disorder, the mother's education, and the young person having a severe illness, are significant determinants of his mental health status.

This review of literature covers about 40 determinants of the mental health status. The available data for Egypt has allowed for 26 determinants of them (whether directly from the survey or by creating some new variables from the available survey data), as shown in **Figure 1**.

2.3 Nutritional Behavior Determinants

There are several theoretical perspectives when studying the determinants of the nutritional behavior: the economic perspective (for the country, the society and the family), the biological perspective (physiological factors, genetic factors), the anthropological perspective (heredity from the far ancestors), the psychological perspective (e.g. cognitive and affectionate factors), the socio-cultural perspective, and the home-related perspective (Gedrich, 2003; Sleddens et al., 2015).

Many empirical and review-type studies have investigated the determinants of the nutritional behavior whether worldwide or in the African, Arab, or MENA countries including Egypt. Nassar et al. (1992) highlighted some important determinants of the healthiness of the nutrients' intake for the Egyptian citizens, namely, the family income, mother and father education, family size, place of residence (urban/rural), infectious diseases, food availability (agricultural production and imports) and food affordability (prices). Neumark-Sztainer et al. (1996) found that family connectedness, weight dissatisfaction, and frequent dieting, are all significant determinants of the nutritional behavior. Neumark-Sztainer et al. (1999) highlighted many of the factors perceived as influencing the adolescents' nutritional behavior, such as the habit,

the taste preferences, the food cost, time constraints of the parents, the parental influence, and the mass media.

Also, Story et al. (2002) marked many determinants of the nutritional behavior and classified them into individual (intra-personal), social environmental (inter-personal), physical environmental (community settings) and macro-system (societal) influences. Jenkins and Horner (2005) highlighted many determinants of the adolescents' nutritional behavior, among them; lack of concern about the healthy eating, limited availability of healthy food in home and in school, and lack of parental/school support and modeling. The United Nations Children Fund (UNICEF, 2008) presented a theoretical framework for malnutrition in which many determinants of the inadequate dietary intake are highlighted and classified mainly into: basic causes related to the structure and processes of the society, underlying causes influencing households and communities, and immediate causes operating at the individual level. Other significant determinants of the young people's nutritional behavior are: the parents' interest in family meals (Videon & Manning, 2003), the parenting style (Kremers et al., 2003), and the intra-household food's distribution (Pieters et al., 2013).

This review of literature covers about 90 determinants of the nutritional behavior. The available data in Egypt has allowed for 20 determinants of them (whether directly from the survey or by creating some new variables from the available survey data), as shown in **Figure 1**.

2.4 Effect of Nutrition on Education
Food Items as the Nutrition Variable

Ivanovic et al. (1992) studied the relationship between food habits (consumption of fruits, vegetables, dairy, meats, eggs …etc) and the educational achievement for the *Chilean students (13-19 years old)* using a cross-section sample of 550 students and applying multiple regression modeling. The results show that the educational achievement was significantly and positively associated with the frequency of consumption of dairy, meats, and eggs, and abnormally, negatively associated with consumption of fruits and vegetables.

Kristjánsson et al. (2010) estimated the relationship between dietary habits, some other variables and the academic achievement for the *Icelandic adolescents* using a cross-section sample of 6346 adolescent students and applying structural equation modeling. The results show that good dietary habits (consumption of fruits and vegetables) were associated with higher academic achievement, while poor dietary habits were negatively associated with academic achievement.

Kim et al. (2010) investigated the association between fish intake and academic achievement for the *Swedish adolescents* using a cross-section sample of 9448 adolescent students and applying multiple linear regression modeling while adjusting for potential covariates (e.g. parents' education). The results show that students with fish consumption once a week have higher grades compared to those with fish consumption of less than once a week. The grades were even higher in students with fish consumption of more than once a week compared with the reference group.

The Nutrients as the Nutrition Variable

Gewa et al. (2009) studied the association between the dietary micronutrients (dietary iron, zinc and B vitamins) and the cognitive test scores among the *rural Kenyan school children* using two-year longitudinal sample of school children and applying the analysis methods of randomized controlled studies and longitudinal regression modeling. The results show that dietary iron, zinc, vitamin B12 and riboflavin have significant positive association with cognitive test scores, after controlling for some confounders.

Dissanayake et al. (2009) studied the association between the iron status (based on hemoglobin and serum ferritin levels) and the educational performance of *Srilankan adolescents* using cross-section comparative study among 188 adolescent students (94 matched pairs) and applying multiple regression analysis where all possible confounders were considered. The results show that there is no significant association between the two variables.

2.5 Effect of Mental Health on Education

DeBerard et al. (2004) have examined potential psychosocial predictors (mental health status among them) of the academic achievement of *American college freshmen* using a longitudinal sample of 204 undergraduate college students and applying a multiple linear regression equation using 10 predictors. The results show that the mental health status was a significant predictor of educational achievement.

Johnston et al. (2014) have examined the effect of survey measurement error on the relationship between the *English students'* mental health and educational progress using a cross-section sample of 6608 students (5-16 years old) and comparing two different methods; the 1st is the structural equation modeling and the 2nd is the classical method of proxy-variable regression modeling The results show that the effect of mental disorder on educational attainment is significant.

Some other studies found a significant relationship between the mental health status and the different education's measures, e.g., (Roy et al., 2016).

One study (University of Columbia, 2011) has made a short report reviewing this relationship for the *American adolescents* (13-18 years old). They have summarized many results, but haven't described each study, and haven't mentioned whether it is a quantitative with significant results or just a qualitative one. All their reviewed studies showed a relationship between the two variables.

3. The Theoretical Framework

Figure 1 describes the suggested theoretical framework for the current study (the E-M-N Moderation Model), based on and extending the reviewed literature. We highlight the following:
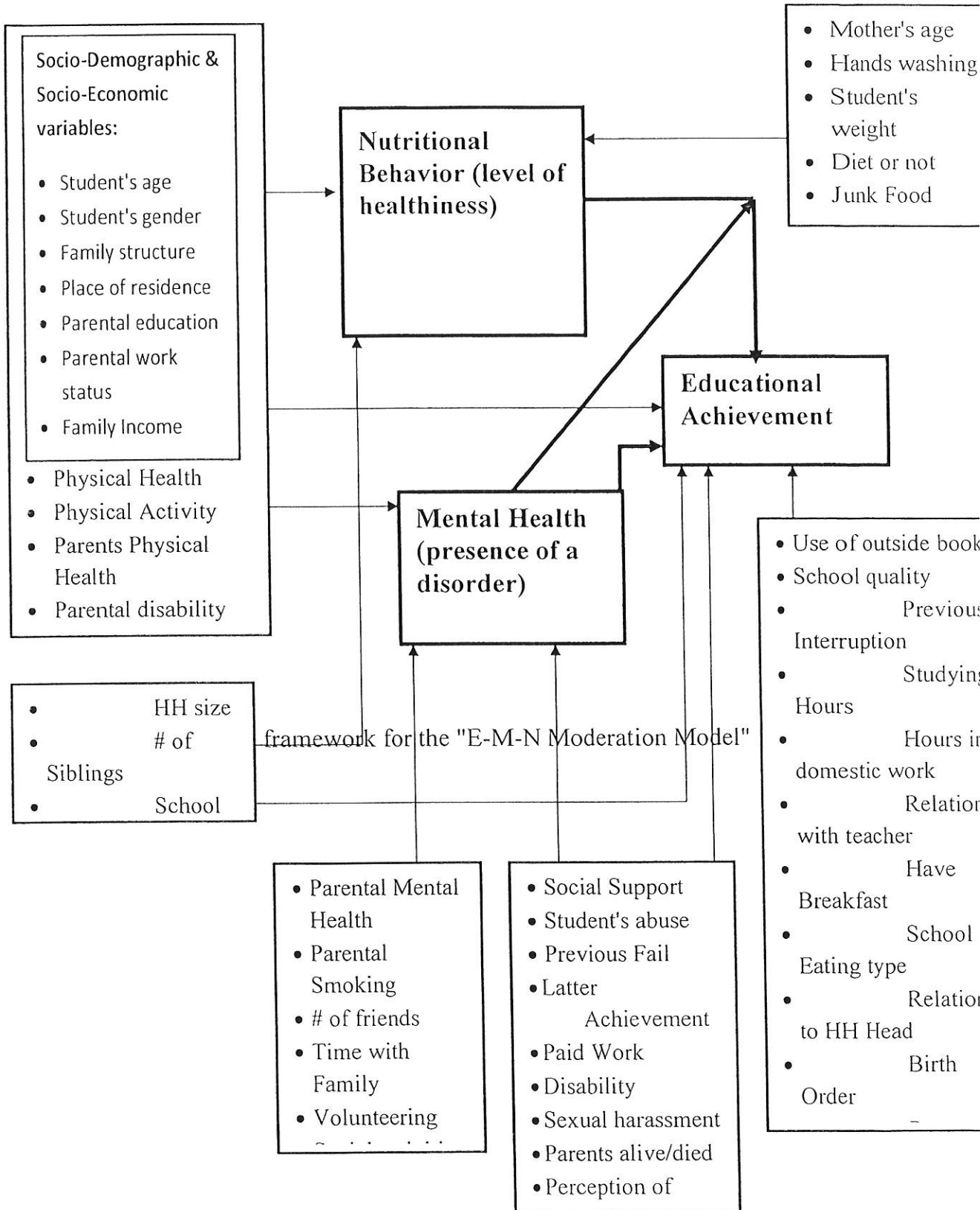
Socio-Demographic & Socio-Economic variables:

- Student's age
- Student's gender
- Family structure
- Place of residence
- Parental education
- Parental work status
- Family Income

- Physical Health
- Physical Activity
- Parents Physical Health
- Parental disability

-          HH size
-          # of Siblings
-          School

Nutritional Behavior (level of healthiness)

Mental Health (presence of a disorder)

Educational Achievement

- Mother's age
- Hands washing
- Student's weight
- Diet or not
- Junk Food

- Parental Mental Health
- Parental Smoking
- # of friends
- Time with Family
- Volunteering

- Social Support
- Student's abuse
- Previous Fail
- Latter Achievement
- Paid Work
- Disability
- Sexual harassment
- Parents alive/died
- Perception of

- Use of outside book
- School quality
-          Previous Interruption
-          Studying Hours
-          Hours in domestic work
-          Relation with teacher
-          Have Breakfast
-          School Eating type
-          Relation to HH Head
-          Birth Order

Figure 1: Theoretical framework for the "E-M-N Moderation Model"

1) The arrow from the mental health to the educational achievement is based on the previous empirical studies about the univariate relationship between the independent variable "mental health status" and the dependent variable "educational achievement".

2) The mental health besides being an independent variable in the education equation, can be hypothesized as an endogenous variable that could be estimated from the same model. This suggests a simultaneous recursive (not reciprocal) relationship between the educational achievement and the mental health status.

3) The previous two comments for the mental health apply for the nutritional behavior.

4) The arrow from the mental health toward the arrow from the nutritional behavior to the educational achievement represents the moderation effect of the mental health for the relationship between the other two variables. A moderator variable is a predictor variable that influences the direction and/or strength of the relationship between another predictor variable and the dependent variable (Baron & Kenny, 1986). This is an exploratory hypothesis in the current study, where the researcher hypothesizes that the effect of the short-term nutritional behavior on the educational achievement is lower at the higher levels of mental disorder, and vice-versa.

4. The Data

The research is based on the data from SYPE-2009, a survey conducted on a nation-wide representative sample from the Egyptian young people (Population Council, 2011). It is a cross-section data. The current analysis is conducted on two sub-samples from this survey, i.e. we have two sub-populations. The first is the Egyptian students who have passed the General Preparatory Certificate and are enrolled in the 1st or 2nd year of general or vocational secondary schools during the survey (1st sub-sample of size 675). The 2nd sub-population is the Egyptian students who have passed the General Secondary Certificate and are enrolled in the 1st or 2nd year of university or above intermediate institute during the survey (2nd sub-sample of size 448). The researcher has chosen these two sub-samples because the only available measure of educational achievement for the young people (adolescent & youth) in the survey was the total score of the General Preparatory Certificate and the total score for the General Secondary Certificate.

SYPE-2009 is a multi-stage stratified cluster sample covering all the governorates in Egypt (Population Council, 2011). It is suitable for this study since it is unique in that it contains an assessment of the student's educational achievement together with his mental health status and his food items intake.

General Data Quality Assessment

General data validity is questionable; when screening the data, some contradictory responses and some illogical responses are found. This may be due to transcription errors in SYPE-2009. As for the reliability of data in general, the data cleaning and quality assessment are not documented in SYPE-2009. Also, the data quality problems are not clearly described in the final reports.

5. The Methodology

In the following we begin by investigating the statistical technique selected in the current study, then we introduce the constructed statistical model.

5.1 The Statistical Technique

The model of the current study is a system of three simultaneous equations in which the three dependent variables "educational achievement", "mental health" and "nutritional behavior" are continuous, ordinal and ordinal type variables respectively (as clarified in next section). Hence, the statistical method needed is a one that: 1) can model and analyze a system of simultaneous equations. 2) can deal with the issue of the mix of continuous and categorical type dependent variables.

The structural equation modeling technique (SEM) is one of the statistical methods that are used to model and analyze the systems of simultaneous equations. And recently, this technique with the computer package Mplus (Muthén & Muthén, 1998-2015) becomes unique - among the full information methods of estimation - in providing the capability to estimate a mix of continuous and categorical type dependent variables using the WLSMV (weighted least squares with adjusted standard errors and mean- and variance-adjusted chi-square test statistic) (Kline, 2015; Muthén & Muthén, 1998-2015; Schumacker & Lomax, 2010). Hence, the SEM technique has been chosen to model and analyze our model.

The structural equation modeling technique (SEM)

A structural equation model consists of two parts: 1) the measurement model part (confirmatory factor analysis) when there are latent factors with their indicators in the model. 2) the structural model describing the relationships between the observed and/or the unobserved (latent) variables. When all the variables in the structural model are observed and there is more than one dependent endogenous variable in the model, this is called the path analysis which is used to model and analyze a set of simultaneous equations of observed variables (Bollen, 2014; Kaplan, 2008; Raykov & Marcoulides, 2012a).

Like any statistical model a structural equation model has 5 steps: model specification, identification, estimation, testing, and re-specification (Cheung, 2015; Kline, 2015; Wang & Wang, 2012).

Different estimation methods for the possible different situations - concerning the joint distribution of the dependent variables - are provided under the context of (SEM), e.g.: the maximum likelihood (ML), the generalized least squares (GLS), the robust ML (MLR), the weighted least squares (WLS), and the weighted least squares with adjusted standard errors and mean- and variance-adjusted chi-square test statistic (WLSMV) (Kline, 2015; Schermelleh-Engel et al., 2003).

5.2 The Model of the current study (The E-M-N Moderation Model)

We begin by defining the variables of the model, then we define the model by the SEM formulation.

5.2.1 The Variables

The correlation matrix test was performed to elucidate the relationships between all the variables to determine which to include in the structural equation model. The pairwise correlation coefficients are significant (p-value < 0.05) with acceptable values for all the variables except: number of siblings, parents' mental health, parental smoking, student's disability status, sexual harassment, student's previous interruption of going to school, student's relation with teacher, student's relation to household head, parents' involvement in the child's schooling and studying issues, and student's satisfaction with schooling experience. Hence, these variables are excluded from the model. . Also, one variable is excluded from the model for having a high non-response rate (about 50% of the observations in each sub-sample), namely, the "student's previous academic achievement".

In the current study, the relevant survey's variables in addition to the created variables are used as either endogenous or exogenous observed variables. An exogenous variable is an independent variable that is not affected by other variables, while an endogenous variable is a dependent or an independent variable affected by other variables (Garson, 2015). We have three endogenous variables, namely, the "educational achievement", the "mental health" and the "nutritional behavior", while the remaining variables are exogenous. **Table 1** shows the description of the variables included in the "E-M-N Model" and the method of their construction.

Table 1: The variables of the model

Variable in the theoretical framework	Variable in model	Variable in survey (**)	Value in survey (**)	Value in model / variable type (***)
Educational Achievement	**Educ** - Score of the General Preparatory Certificate for the students in the 1st sub-sample - Score of the General Secondary Certificate for the students in the 2nd sub-sample	Similar	Score in %	Score in % (continuous)
Mental Health	**Ment** Level of presence of a common mental disorder	A question of 20 yes/no items	For each item: 1 yes 2 no	Sum of the 1's : The higher the score the more the level of presence of a common mental disorder (ordinal)
Nutritional Behavior	**Nutr** Level of healthiness of the nutritional behavior	A question about 11 food items: meat, fish, chicken, egg, dairy products fresh vegetables cooked vegetables foul & legumes potatoes rice/pasta	Frequency of consumption per week of each food item: 1 Never 2 (1-3) times 3 (>3) times	Simple aggregation of the response about the 11 food items: The higher the score the higher the level of healthiness (ordinal)
School quality	**Sc_Quali** Student's perception of school & teacher quality	A question of seven items about some characteristics of the teacher and the school	For each item: 1 Always 2 Sometimes 3 Never	Scores from a factor analysis: The higher the score the higher the school quality (continuous)
Physical Health	**Phys_HL** Student has a health problem	A question about whether having any disease among 17 diseases	yes/no for each of the 17 diseases	0 no * 1 yes (if at least one yes) (binary)

Social Support	**Pers_Is** Level of discussing personal issues with close persons	A question of six items about discussing some personal issues with close persons	For each item: 1 Never 2 Rarely 3 Sometimes 4 Always	Scores from a factor analysis: The higher the score the higher the level (continuous)
	Fl_Loved The student feels loved by his family	Similar	1 yes 2 no	0 no * 1 yes (binary)
	Rel_Frnd The student has friends can trust	Similar	1 yes 2 no	0 no * 1 yes (binary)
	Pa_Talk (1/2/3) Discussing critical issues (puberty/ HIV) with parents	Discuss puberty with parents	1 yes 2 no	0 Not possible * (if both no) 1 Somewhat (if one yes) 2 Possible (if both yes) (ordinal)
		Discuss HIV/AIDS with parents	1 yes 2 no	
Student's Weight	**Stud_Wei** Student & interviewer's perception of student's weight	Student's perception of his weight	1 Very underweight 2 Slightly underweight 3 About the right weight 4 Slightly overweight 5 Very overweight	Scores from a factor analysis of both variables: The higher the score the higher the weight (continuous)
		Interviewer's perception of student's weight	"	
Perception of Population Values	**Pop_Valu** student's perception about values' existence in population	Perception about sense of responsibility in population	10 points scale: 1 Absent 10 Present	Scores from a factor analysis of both variables: The higher the score the higher the perception (continuous)
		Perception about values of hard work in population	"	
Junk Food	**N_H_Food** Level of eating Junk Food (unhealthy food)	A question about 4 food items: Sweets Soft drinks Fast Food Pastries (chips…)	Frequency of consumption per week of each food item: 1 Never 2 (1-3) times 3 (>3) times	Scores from a factor analysis: The higher the score the higher the level of eating (continuous)

Parent's Education (****)	Fa_Educ (1/2/3/4/5/6/7) Father Education	A question about the highest level of education attended	10 categories	0 Illiterate * 1 Read / Write 2 Primary 3 Preparatory 4 Vocational 5 Secondary / Above Intermediate 6 University (ordinal)
	Mo_Educ (1/2/3/4/5/6/7) Mother Education	"	"	"
Birth Order	Birth_Or Birth order between siblings	No direct question. Got by logical manipulations in the survey's data file	-	Birth Order value (continuous)
Studying Hours	Study_Hr # of hours spent in studying & related activities	Homework/studies at home	# of hours	Sum of hours (continuous)
		Private or group tutoring	# of hours	
Hours in Domestic Work	HH_Hr # of hours spent in domestic duties	Household chores inside the house	# of hours	Sum of hours (continuous)
		Household chores outside the house	# of hours	
		Care of children, sick or elderly	# of hours	
Parent's Work Status (****)	Fa_Work (1/2/3/4) Father work status	A question about the employment status now	6 categories	0 Unemployed * 1 Wage Employee - Part Time 2 Wage Employee – Permanent 3 Employer / Self-Employed (ordinal)
	Mo_Work (1/2/3) Mother work status	"	"	0 Unemployed * 1 Wage Employee - Part Time 2 Wage Employee – Permanent (ordinal)
# of friends	Nb_Frnd Number of Friends	A question about the number of friends	# of friends	# of friends (discrete)

Parent's Physical Health (****)	**Fa_Disea** Father physical health status	A question about having a chronic disease	1 yes 2 no	0 no * 1 yes (binary)
	Mo_Disea Mother physical health status	"	"	"
Parent's disability (****)	**Fa_Disab** Father disability status	A question about having a disability	1 yes 2 no	0 no * 1 yes (binary)
	Mo_Disab Mother disability status	"	"	"
HH size	**HHsize** The number of household's members	No direct question. Got by logical manipulations in the survey's data file	# of persons	# of persons (discrete)
School type	**Sch_Type** The school type	A question about the type of school	1 governmental 2 private	0 governmental* 1 private (binary)
Time with Family	**Famil_Hr** # of hours spent with family	A question about the number of hours spent with family	# of hours	# of hours (continuous)
Student's abuse	**Sc_Abus (1/2/3)** Student's opinion about school abuse existence	A question about the student's opinion on whether some teachers//instructors beat students and use corporal punishment	1 always 2 sometimes 3 never	0 never * 1 rarely 2 always (ordinal)
	P_Treat (1/2/3/4) Parent's way of treating their children	A question about how the student's parents react if he misbehaves	6 categories	0 Do Nothing * 1 Explain why the behavior was wrong 2 Don't give money 3 Severe reaction (ordinal)
Stress	"	"	"	"
Volunteering	**Voluntee** Student participate in one or more volunteering services	A question about participating in any of 6 volunteering services	yes/no for each of the 6 services	0 no * 1 yes (if at least one yes) (binary)

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Physical Activity	**Ph_Activ** Student's day includes some physical activity	A question about whether the student's day includes any of 6 physical activity	yes/no for each of the 6 activities	0 no * 1 yes (if at least one yes) (binary)
Social activities	**Socio_Gr** Student participate in one or more social activity groups	A question about participating in any of 11 social activity groups	yes/no for each of the 11 social groups	0 no * 1 yes (if at least one yes) (binary)
Extra-curricular	"	"	"	"
Previous Fail	**Fail (1/2/3)** Student ever fail a class or a year	Ever fail a class and repeat an examination in any year	1 yes 2 no	0 no * (if both no) 1 a class or a year (if one yes) 2 yes (if both yes) (ordinal)
		ever repeat any school year	1 yes 2 no	
Paid Work	**Work** Student ever worked while studying	A question about whether the student ever worked while studying	1 yes 2 no	0 no * 1 yes (binary)
Parents alive/died (****)	**Fa_Pres (1/2/3)** Father presence or death status	A question about presence or death status	0 alive not present in HH 1 alive present in HH 2 died	0 died * 1 alive not present in HH 2 alive present in HH (ordinal)
Perception of Future	**Future** Student's perception of his future	A question about the degree that reflects the student's' feeling of uncertainty about his future	10 points scale 1 non-ambiguous 10 too vague	Value from the scale (continuous)
Hands washing	**Hands** Student usually washes his hands with soap after using the bathroom	A question about washing hands with soap after bathroom	1 yes 2 no	0 no * 1 yes (binary)
Diet or not	**Diet (1/2/3/4)** Student current action toward his weight	A question about what the student is currently doing about his weight	1 nothing 2 lose weight 3 gain weight 4 maintain weight	0 nothing * 1 lose weight 2 gain weight 3 maintain weight (ordinal)

Mother's age (****)	Age_Mo Mother's age	A question about age	Age in years	Age in years (continuous)
Use of outside books	Out_Book Student uses outside books	A question about whether the student uses any outside books	1 yes 2 no	0 no * 1 yes (binary)
Have Breakfast	BreakFa (1/2/3/4/5) Student eating for breakfast	A question about how often the student eats breakfast	1 never 2 rarely 3 sometimes 4 most of the time 5 always	0 never * 1 rarely 2 sometimes 3 most of the time 4 always (ordinal)
School Eating type	Eat_Sch (1/2/3) Student eats during school day	A question about what the student eat at school	1 something I buy 2 sandwich 3 nothing	0 nothing * 1 something I buy 2 sandwich (ordinal)
Relation to HH Head	Rel_HHH (1/2/3) Student relation to household head	A question about relation to household head	11 categories	0 son/daughter * 1 grandchild 2 other (ordinal)
Enrollment age	Age_Enro Student's age at enrollment in the 1st primary	A question about the student's age at enrollment in the 1st primary	Age in years	Age in years (continuous)
Kindergarten	Kinderga Student ever been to a nursery/ kindergarten	A question about ever been to a nursery/kindergarten	1 yes 2 no	0 no * 1 yes (binary)
Student's Age	Age Student's age	A question about student's age	Age in years	Age in years (continuous)
Student's Gender	Gender Student's gender	A question about student's gender	1 male 2 female	0 male * 1 female (binary)
Place of Residence	Region (1/2/3/4) Region of residence	A question about the region of residence	1 Urban Governorates 2 Lower Egypt 3 Upper Egypt 4 Frontier Governorates	0 Urban Governorates 1 Lower Egypt 2 Upper Egypt 3 Frontier Governorates (ordinal)

Family Income	WealthQ (1/2/3/4/5) Wealth index quintiles	Several questions about housing quality variables, namely variables about household asset ownership and variables about housing characteristics	yes/no for each question	Scores from a factor analysis performed by the Population council (2011), then partitioned to 5 categories : 0 lower * 1 lower middle 2 middle 3 upper middle 4 upper (ordinal)

(*) Reference category

(**) (Population Council, 2011)

(***) For the variables created using the factor analysis (Raykov & Marcoulides, 2012b) : Stata13 package (Stata, 1985-2013) and the user-written command "polychoric" was used. The Cronbach Alpha measure of reliability (Garson, 2013) is acceptable. We have relied on the Polychoric Correlation Matrix rather than the Pearson's Correlation Matrix, since the items are ordinal variables, getting more accurate results. The principal components method of extraction and the VARIMAX method of rotation have been applied.

(****) All parent's variables are got using the linking procedures of an observation (the student) with another observation (his father or his mother) in the survey's data file.

Data Quality Assessment of the Three Endogenous Variables

The Educational Achievement Variable

The validity of the SYPE-2009 module of education is questionable. There is a high non-response rate (missings) which seems to be not at random. Also, the response is self-reported which may be not accurate due to biasness or week memory.

The Mental Health Variable

The reliability of the SYPE-2009 module of mental health is questionable. Although the calculated measure of reliability "Cronbach alpha" (for each sample) ≈ 0.85 which is good, yet the inter-item correlation for the 20 items of the module (for each sample) ≈ 0.2 which is very low and unacceptable (Garson, 2013). Also, the answer for each item is only yes/no, while it is better to be a scale of at least 5 levels. As for the validity of the module, the tool SRQ-20 of the mental health module developed by the WHO should be first tested in the society by comparing its results with the clinical diagnostics, to make sure that it really reflects a mental disorder not only some stress or distress.

The Nutritional Behavior Variable

The validity and precision of the SYPE-2009 module of nutrition are questionable: it is very limited in the information needed to reflect the level of healthiness of the diet pattern. Hence, none of the standard methods of constructing a variable measuring the level of healthiness of the nutritional behavior could be applied. Also, it is not that reliable because it relies on the memory of the students to recall the food items for the past week, the results of which are questionable. In addition, the module is concerned only with the general data for one week not an average of a long period.

5.3 The Structural Equation "E-M-N Moderation Model"

Since the study's model is a system of three simultaneous equations where all the variables are observed, hence it is a path analysis model. Since the "mental health" variable is hypothesized to be a moderator variable, hence, following Kline (2015) , two things should also be specified in the model: 1) an interaction term (M*N) of "the mental health" and the "nutritional behavior" in the path of the "educational achievement". 2) two covariances, one between the interaction term and the "mental health" and another between the interaction term and the "nutritional behavior". **Figure 2** shows the model of the current study (E-M-N Moderation model) in the notation of the SEM technique. The figure is produced by the SEM package Mplus 7.4 (Muthén & Muthén, 1998-2015).

As for the model identification issue; the "E-M-N Moderation model" is a recursive type model and its degrees of freedom >= 0, so it is an identified model (Kline, 2015).

Since SYPE-2009 is a multi-stage stratified cluster sample, hence each of our sub-samples is not a simple random sample. The relative specific feature in Mplus has been used to specify the complex (stratified) design. Moreover, the usual problems of model building, namely: the multicollinearity, the heteroscedasticity, the outliers and leverage points, the missing data, and the relative variance of the continuous variables, have all been handled properly using Mplus 7.4 package.

The estimation method applied is the WLSMV (weighted least squares with adjusted standard errors and mean- and variance-adjusted chi-square test statistic), built in the Mplus 7.4 package, in order to account for: 1) the mix of continuous and categorical type dependent variables, 2) the complex (stratified) survey data, 3) the detected heteroscedasticity.
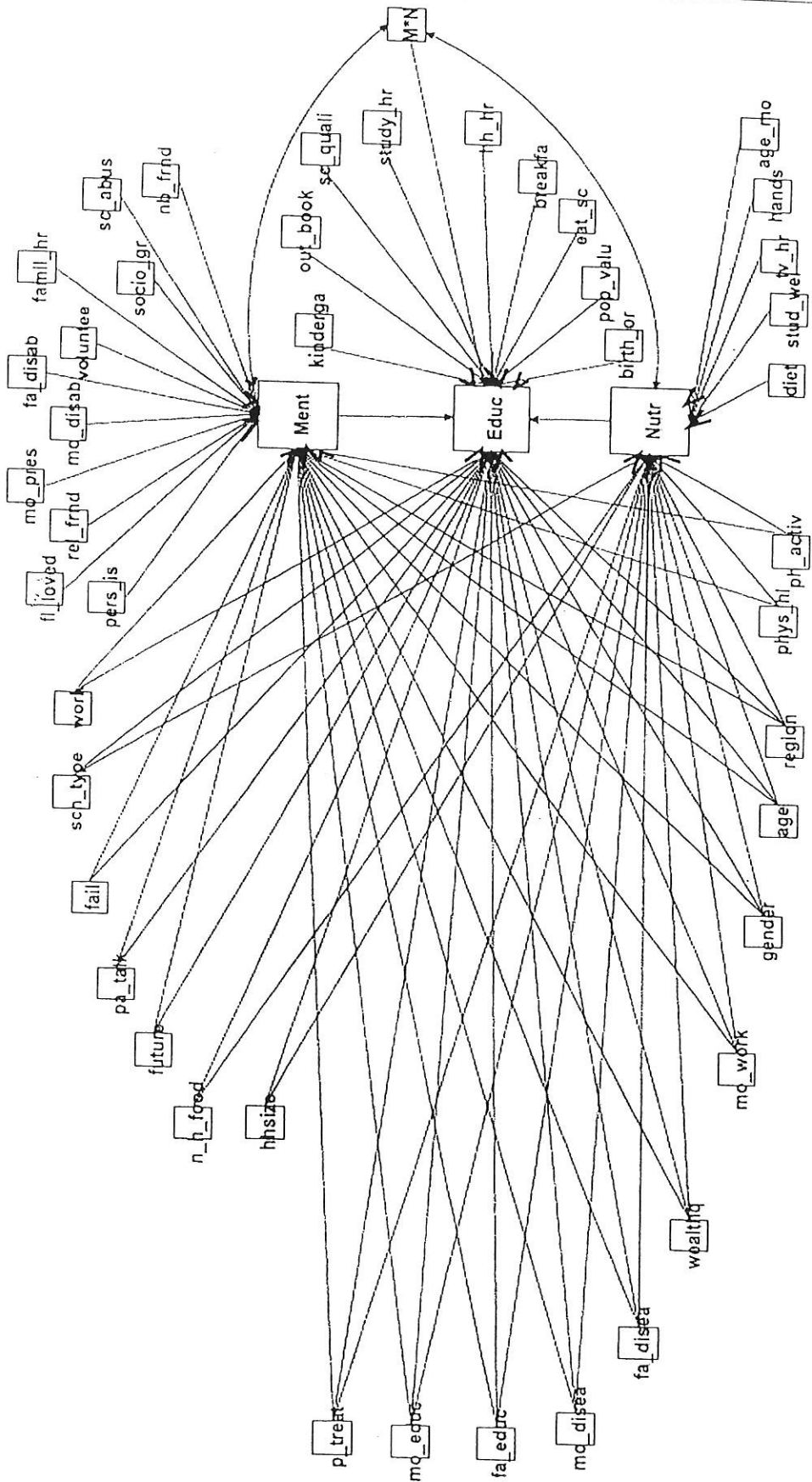
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Figure 2: The E-M-N Moderation Model (Produced by Mplus 7.4 package)

6. Results and Discussion

The analysis has been performed on the SEM package Mplus 7.4 for each sub-sample.

Cheung (2015); Kline (2015); and Schermelleh-Engel et al. (2003) have clarified that to evaluate a structural equation model and judge its fit and its significance, the chi-square test statistic should be used in combination with an absolute fit index and an incremental fit index. They clarified that the best combination is: the chi-square test statistic together with its degrees of freedom and its p-value, the absolute fit index "root mean square error of approximation (RMSEA)" together with its confidence interval and probability to be (<=0.5), and the incremental fit index "comparative fit index (CFI)". The guidelines stated in these references about the suggested cutoffs for these fitting criteria have been followed. **Table 2** shows the results concerning the significance and the goodness of fit of the model for each sub-sample.

Table 2: Significance and goodness of fit of the E-M-N model for the 1st and the 2nd sub-samples

Fit Criteria	Cut-off Guidelines		Computed values	
	Good Fit	**Acceptable Fit**	**1st sub-sample**	**2nd sub-sample**
df	-	-	145	145
χ^2	$0 \leq \chi^2 \leq 2df$	$2df < \chi^2 \leq 3df$	183.280	135.660
χ^2/df	$0 \leq \chi^2/df \leq 2$	$2 < \chi^2/df \leq 3$	1.264	0.936
p-value	$0.05 < p \leq 1.00$	$0.01 \leq p \leq 0.05$	0.0172	0.6989
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 < RMSEA \leq 0.08$	0.024	0.000
Prob. (<=0.05)	$0.10 < p \leq 1.00$	$0.05 \leq p \leq 0.10$	1.000	1.000
90 Percent C.I.	close to RMSEA, left boundary = 0.00	close to RMSEA	0.011 - 0.034	0.000 - 0.021
CFI	$0.97 \leq CFI \leq 1.00$	$0.95 \leq CFI < 0.97$	0.951	1.000
n	-	-	449	329

Based on the cut-off guidelines, the "E-M-N Moderation Model" is significant and acceptable fit for the 1st sub-sample, and is significant and a good fit for the 2nd sub-sample.

Figure 3 and **Figure 4** show the results concerning the significant relationships for the 1st sub-sample and the 2nd sub-sample respectively.

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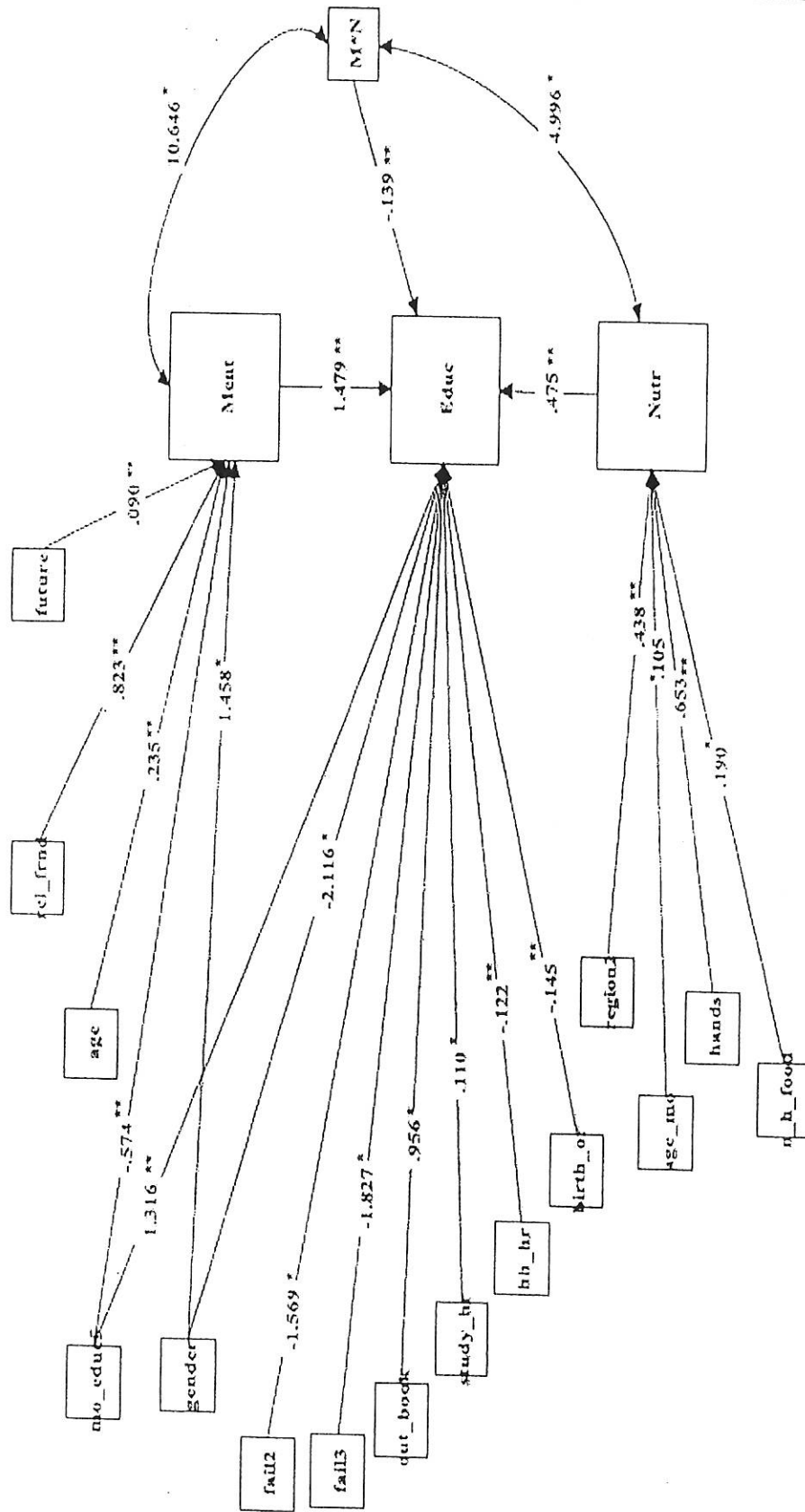
44

Figure 3: Results of the E-M-N Moderation Model for the 1st sub-sample – significant relationships (Produced by Mplus 7.4 package). *Significant at 0.05
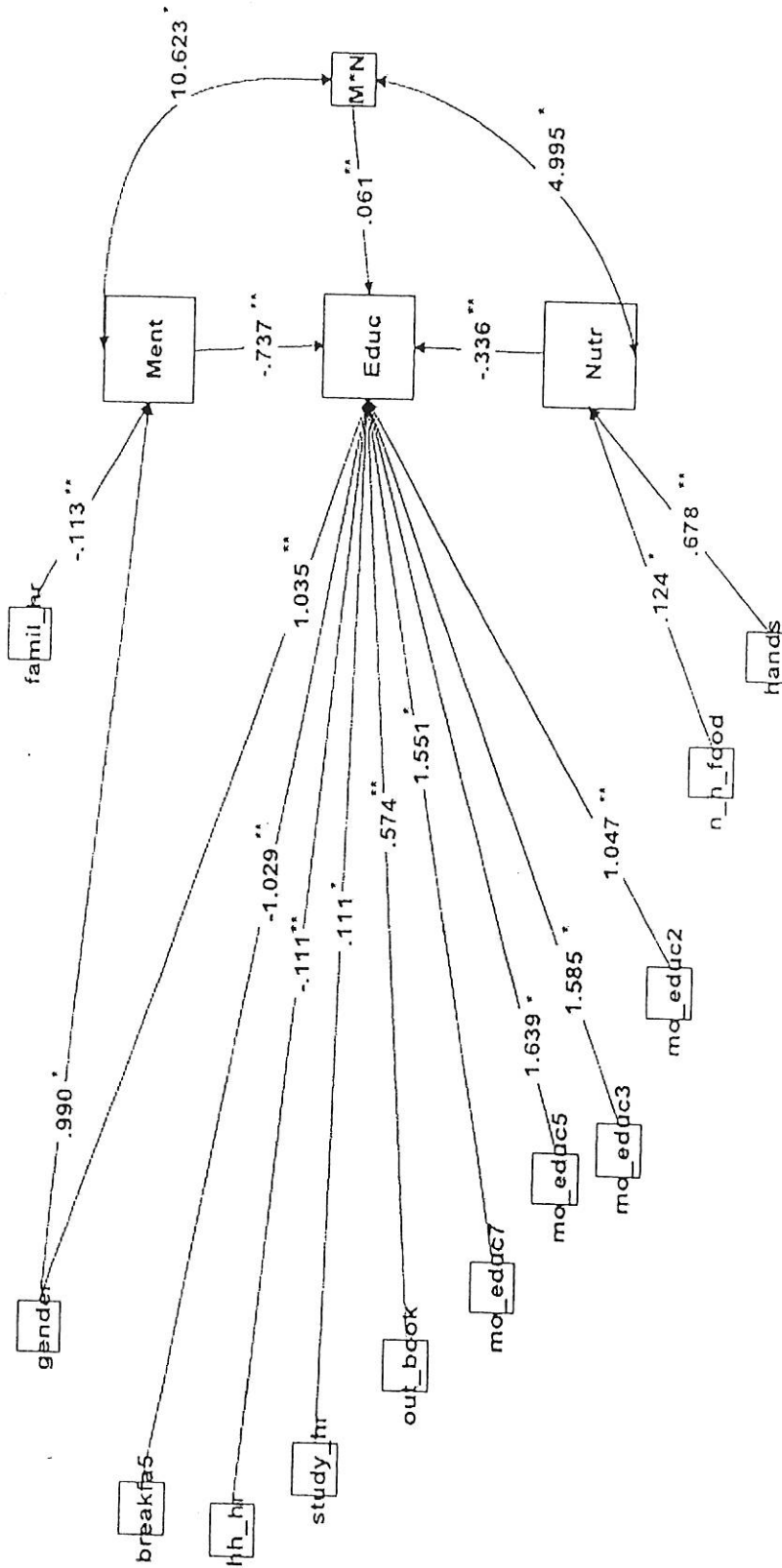**Significant at 0.01   ***Significant at 0.1

Figure 4: Results of the E-M-N Moderation Model for the 2nd sub-sample – significant relationships (Produced by Mplus 7.4 package). *Significant at 0.01 **Significant at 0.05 ***Significant at 0.1

6.1 The Simultaneous-Moderation Hypotheses

Figures 3 and 4 show that both the relationships (Educ - Ment) and (Educ - Nutr) are significant in the two sub-samples. For the 1st sub-sample the sign of the relationship (Educ – Ment) is negative as expected, but, the sign of the relationship (Educ – Nutr) is negative in contrast with the priori-expectations. For the 2nd sub-sample the opposite has happened, the sign for (Educ – Ment) is positive in contrast with the prio-expectations, while the sign for (Educ – Nutr) was positive which agrees with the expectations. Therefore, the hypothesized theoretical idea of the study (the simultaneous-moderation hypotheses) does not seem to be true in Egypt.

6.2 Variables Affecting the "Educational Achievement"

Figures 3 and 4 show that the variables that have a significant positive effect on the educational achievement in both sub-samples are: The use of outside book, the number of hours spent in studying & related activities, and the mother education being with a vocational secondary certificate compared to being illiterate. The determinants that have a significant negative effect on the educational achievement in both sub-samples are: the number of hours spent in the domestic duties, and the father education being with a vocational secondary certificate compared to being illiterate.

Several other important significant effects that are specific for each sub-sample alone and hence can characterize each target population on its own can also be detected, e.g. being a female has a negative effect on the educational achievement when it is the score of the General Preparatory Certificate, while it has a positive effect when it is the score of the General Secondary Certificate.

Some unexpected and illogical effects can also be seen, e.g. always eating breakfast compared to never eat it has a negative effect on the score of the General Secondary Certificate.

6.3 Variables Affecting the "Mental Health"

Figures 3 and 4 show that there is no significant variable for both sub-samples except being a female which has a positive effect i.e. it is associated with the increase in the level of presence of a mental disorder.

The mother education (vocational secondary certificate compared to illiterate) has an inverse relation with the level of presence of a mental disorder for her child in the 1st target sub-population. As for the 2nd target sub-population, it is the mother education (university certificate compared to illiterate) which has an inverse relation with the level of presence of a mental disorder for her child.

An interesting result is that for the students in the 1st target sub-population, being in Upper Egypt or Lower Egypt compared to living in the Urban Governorates is associated with lower levels of presence of a mental disorder. Also, unexpectedly there seem to be a positive association between the level of discussing personal issues with close persons (as a proxy for the social support) and the level of presence of a mental disorder for the students in the 1st target population.

6.4 Variables Affecting the "Nutritional Behavior"

Figures 3 and 4 show that the two variables that have a significant positive effect on the nutritional behavior in both sub-samples are the fact that the student usually washes his hands with soap after using the bathroom which lowers the probability of infectious diseases that lowers the intake of food including the healthy food. The 2nd variable is the level of eating junk food which is unexpected.

Other interesting results are that being in Lower Egypt compared to the Urban Governorates is associated with higher levels of healthiness of the nutritional behavior for the 1st sub-sample. Moreover, the fact that the parents' reaction if their child misbehaves is a severe reaction compared to "do nothing"(and as proxy for the stress) is associated with lower levels of healthiness of the nutritional behavior, which is expected.

7. Discussion and Recommendations

7.1 Discussion

The paper presents a new model – the "E-M-N Moderation Model" – testing the simultaneous-moderation hypotheses using the SEM technique. The relevant statistical assumptions have been tested and the violations have been treated. However, the results show that based on the available data, the hypotheses of simultaneous-moderation do not seem to be true in Egypt. This could be due to one of three possible reasons: **1)** The theoretical idea behind building the model is really not true **2)** The model is false, whether statistically, logically or in the syntax. **3)** There are important limitations for the study.

The first two reasons do not apply here because:

1) The hypothesized idea is based on previous empirical results that show evidence about the univariate relationships, and the determinants of each of the three variables. These results logically can be extended to some form of a simultaneous relationship. Concerning the idea of moderation, it is logical to expect that the positive effect of the short-term nutritional behavior on the educational achievement is lower at the higher levels of mental disorder, and vice-versa.

2) The steps of specification, identification and estimation have been applied, and all the statistical assumptions have been tested, treated and dealt with. Also, the Mplus computer package produces a diagram after the analysis, translating the model into a figure which shows and hence prevents any possible logical or syntax error.

3) As for the third point, the study has some important limitations that are presented throughout the paper; the first is the crucial issue of the data quality, and the second is about the exposure time of the variables:

The data quality issue

As is previously clarified while defining the model's variables; the validity of data in each of the SYPE-2009 modules of nutrition, mental health, and educational achievement is questionable. The reliability of each of the nutrition and mental health modules, and the precision of the nutrition module are also questionable. In addition, the general data validity and reliability are questionable as clarified while introducing the data.

The exposure time issue

Based on the model's variables' definitions, the only measure of educational achievement in SYPE-2009 is the total score of the last academic certificate, while the nutrition module is asking about the frequency range for the consumption of food items in the last week before the survey, and the mental health module hasn't asked about the time where the symptoms had started. This is why the students in only the two successive academic years after the general academic certificate whose scores are reported, were chosen for our samples; to be able to assume in our analysis that the nutrition pattern of the students hasn't changed during this short period. Moreover, it is noted in some studies (Rutter et al., 2006) that young people with mental disorders actually experience the first symptoms in their early adolescence (10 or 11 years old) i.e. before passing the general academic exams of our two sub-samples. Such assumptions might not be realistic.

7.2 Recommendations

The results reveal that the specified E-M-N Moderation Model has an acceptable fit for the 1st sub-sample and a good fit for the 2nd sub-sample, and the relationships between the variables of interest are significant but they are in contrast with the priori-expectations. The researcher argues that the rejection of the study's hypotheses is not due to a possible illogical theoretical hypothesized idea or to an error in the model, but is due to the important limitations of the study.

Generally speaking, Kline (2015) has stated that "success in SEM is determined by whether the analysis dealt with substantive theoretical issues regardless of whether a model is retained".

The researcher recommends that the "E-M-N Moderation Model" carrying the hypothesized idea of the study be re-tested using another dataset, because the simultaneous relationship and the moderation effect may imply specific policies that can save money, effort and time for the policy makers and the parents. It suggests that the policy makers and the parents shouldn't neglect the issue of mental health while spending big amounts of money and effort on the nutrition, since bad mental health alters the good effect of the healthy nutritional behavior on the educational achievement, which implies that policies for the mental health care should be well designed typically in parallel with the policies of nutrition on the national level and within the family. Following are some recommendations:

1) It is recommended to re-test the hypothesized idea of the current study on new datasets, using specialy designed surveys. It is recommended to: **a)** not use the self-reporting for the measure of the educational achievement but rather to use the registries of the schools' administrations. **b)** use the specially designed tools, known in the nutriton science, for measuring the level of healthiness of the nutritional behavior **c)** use the more accurate scales tools known in the psychometrics for measuring the mental health status or use the clinical diagnosis.

2) It is recommended to perform a panel (logitudinal) study, to reduce the bias of the omitted variables. While the controled experiment is statisticaly better by far (evidence of causality) but it is difficult to be conducted in such contexts.

3) In case of non-rejection of the idea, it must be validated using the known validation methods (resampling by bootstrap/jackknife, sample splitting, Mont-Carlo simulation using the matrix of estimated parameters …etc).

4) In case of the non-rejection of the idea, many statistical methods can be used to futhur investigate the idea, e.g. the two-group or multiple-group analysis, the multi-level fixed effect or random effect analysis, the latent construct analysis ...etc.

5) It is recommended that the nutrition experts & relevant specialists in Egypt create a healthy Egyptian-Style Eating Pattern (like that of the USA) that meets the nutrient needs while respecting the Egyptian-style of eating foods (legumes, baladi bread, …etc).

Acknowledgement:

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