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Linking Millennium Development Goals on Education and Health: Analysis of Gender Differences in Health Production in South Africa.

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Abstract

The overall objective of this analysis is to model gender differences in health production, specifically looking at the effects of education attainment.

Analysis of the relationships in this paper is based on the Grossman health investment model, using data from the South African General Household Survey. We feature the role of gender as a key factor mediating part of the causality in the health-education relationship. The measure of health is used as a dependent variable and analysed as a function of gender, education and other socio-economic factors such as age, income, medical care, ethnicity, etc, using a multinomial logit estimator.

The baseline model results show gender differences in reported illness. The effect of education is largely negative; while interaction effects show significant gender differences even for respondents with similar levels of education. For example, given similar levels of education, females may be better able to produce health.

The results highlight the impact of education in the production of health among males and females, and measure (or provide numerical evidence about) the potential impacts of policy variables to improve health. They suggest that policies or interventions designed to provide greater opportunities to educate females are encouraged, as education has greater impact in the health production.

Keywords: Millennium Development Goals, education, Grossman model, gender, health production.

Introduction

Three of the eight Millennium Development Goals (MDGs) are related to health, namely, reducing child mortality, improving maternal health and combating diseases such as HIV/AIDS and malaria by the year 2015. Despite substantial progress made in meeting the set targets, Sub-Saharan Africa (SSA) still lags behind in meeting some of the targets, with less than a year to the end of 2015. The Millennium Development Goals Report for 20141 shows that SSA recorded the highest under 5 mortality rate globally, despite a fall (in under 5 mortality rate) from 177 per 1000 live births in 1990 to 98 per 1000 live births in 20 World Development Report[14] in SSA. SSA also recorded the highest maternal mortality ratio among developing countries, with over 500 deaths per 100,000 live

births[1]. This outcome was recorded despite progress made in terms of deliveries attended by skilled personnel, which showed a 13 percentage points increase between 1990 and 2012. In terms of diseases, HIV incidence rates remain high in SSA, driven mostly by high incidence rates in Southern Africa, which accounted for 70 percent of the estimated number of new infections in 2012. The fight against malaria seems to be meeting set targets, with 90 percent of averted deaths (about 3 million children) coming from SSA[1].

The third goal is the attainment of gender equality and women empowerment. One way of empowering women is by educating them[1]. Through education, individuals can learn to transform their natural environment, not only to attain health needs but also to satisfy other human needs.

Education is a major component in health investment as it increases the marginal efficiency of capital in health production[2,3]. According to Grossman[3], each individual is born with a given health stock which depreciates with age at an increasing rate until death. However, the rate of depreciation of the individual's health stock can be increased or decreased by the individual's (market and non-market) choices which have a positive or negative impact on their health. Examples include individual choices over lifestyles such as diet and drinking, smoking, and exercise, or the use of health care services.

Health has been defined more broadly beyond merely the absence of disease or infirmity[4] to include a balanced improvement in physical, mental and social aspects of positive health, including the prevention of ill health[5]. There are several reasons why an analysis of health production is important. Health yields direct satisfaction and also provides healthy time for productive activities which yield indirect satisfaction through higher future earnings[6]. The results of an analysis of health production can also be useful in that it can help individuals vary their lifestyles to improve health. In addition, healthier people would demand less medical care, which can lead to savings in healthcare expenditures for the general public.

Empirically, a number of researchers have found significant positive effects of education on the demand for health. Education increases the individual's ability to produce better health in that the individual can use the know-how gained through education to transform health inputs into outputs and can also make better choices about their lifestyle and use of healthcare services. An increase in (the level of) education raises the marginal products of the direct inputs in health production, lowers marginal cost and shifts the marginal efficiency of capital (MEC) schedule to the right; therefore the demand for health increases[6]. Researchers[6] estimate the demand for health among males in the pre-retirement years, aged between 45 and 49 years and find significant positive effects of education on health (alongside hourly wage and job attitude). Specifically, they find that wives education had a significant positive impact on the perceived health status of black males, while own education was unrelated to the health status of black males. Other researchers[7] empirically tests Grossman's model to highlight the role of education, as well as the effects of lifestyle and environmental factors on health, and finds that education has an effect on the rate of depreciation of the health stock. In addition, she links the allocative efficiency gains from education to the concept of use-related depreciation of health stock. Wagstaff[8] reformulates the Grossman model in a bid to address some of the problems of Grossman's previous empirical work. He tests the effects of education (and other variables such as gender and age) and confirms the education-efficiency hypothesis. The effect of the number of years of schooling on health is positive and significant among the under 41s but is positive and insignificant among the over 41s.

The relationship between education, gender and health can also offer insights into the achievement of the MDGs. Firstly, education is important to health, while health is central to the MDGs. Secondly, there are perceived gender differences in the way in which education can (does) contribute to health production. This paper analyses gender differences in the role of education in health production. The overall objective of this analysis is to model gender differences in health production, featuring the role of education. To do this, the paper also analyses gender differences in health and in the levels of educational attainment. In addition, it analyses associations between health and education and how these differ by gender.

Brief Background Information about South Africa

South Africa as a country lies between 22 degrees and 35 degrees south of the equator and is surrounded by the Atlantic Ocean on the west and the Indian Ocean on the east. In terms of land area, it is bordered on the North West by Namibia, on the North Central by Botswana and on the North East by both Zimbabwe and Mozambique, and covers a total land area of 1,220,813 square km[9]. The country has an estimated population of 54 million, distributed across 9 provinces. The administrative

capital of South Africa is in Pretoria (Gauteng Province), the legislative capital is in Cape Town (Western Cape Province), and the judicial capital is in Bloemfontein (Free State Province). South Africa has 11 official languages[1], while Zulu is the language spoken by the greatest proportion of the population.

A total 51 percent of the population of South Africa is female. About 11 percent of the population is aged under 5 and approximately 8 percent is 60 years or older, while about 14% of the population has no schooling[9]. Life expectancy (in the year 2013) as indicated in the Global Health Observatory Data Repository published by The World Health Organisation was 56 years for males and 62 years for females. Other statistics from the WHO Global Health Observatory Data Repository on South Africa showed that HIV prevalence rate among adults aged 15-49 years was 19.1 in 2013, and a maternal mortality ratio (interagency estimate) of 140 per 100,000 live births.

Health care is provided mostly by the public sector alongside a small but growing private sector[10]. Basic primary health care is provided free by the state, while the private sector mostly provides specialist care for those who can afford it (private health care is mostly financed through medical insurance schemes known as medical aid schemes).

Methods

Analysis of the relationships in this paper is based on the Grossman model[3]. The measure of health is used as a dependent variable and analysed as a function of gender, education and other socio-economic factors such as age, income, medical care, ethnicity, etc, using a multinomial logit estimator.

Model

Every individual is assumed to have a given stock of health (*h*) which (naturally) decreases or depreciates with age. However, this health stock can be increased or maintained (as the case may be) through investment in health-producing activities. Some of the key elements in the individual's health production function are income and education, among other socio-economic characteristics. We use individuals' reported illness or injury as a measure of their current stock of health. An individual (*i*) can suffer from an illness or not (that is, have a given health state) and this is a function of his characteristics (income, education, age, gender, ethnicity, etc). Therefore they will have functions explaining each health state or outcome as a function of their characteristics. For example, consider that $y_{i1....n}$ defines a specific individual with as many as *n* health conditions. Then several functions could be estimated to evaluate the effects of their characteristics on that health outcome. However, we can simultaneously model the associations between the individual's characteristics and all the health outcomes, since at any specific time, an individual can either have one or more, or even no health problems at all.

We categorise the different health states into a single variable containing indicators for different health outcomes and model this using multinomial logit, with 'no illness or injury' as the base health outcome.

Conceptual Framework

An individual is assumed to combine various inputs to produce the commodity 'health', so as to maximise the utility function:

$$u_i = u(h_{ik}, z_i) \qquad u' > 0,\ u'' < 0 \qquad (1)$$

Where i indexes the individual, (i =1, 2, ….., N), h is a vector of kth health outcomes. z is a vector of consumption of non-heath inputs, assumed to be given. The individual is assumed to maximise Equation (1) subject to the health production function, assumed to take the form:

$$h_{ik} = h(x_i, l_i) \qquad (2)$$

Where k = 1, 2,….., K health outcomes. In Equation (2), the efficiency of producing health is conditioned on x_i, vector of individual characteristics including demographic and socioeconomic circumstances which include education, and l_i is vector of health-related inputs that affect health (e.g. medical service provision, access, coverage, living conditions, etc). Assuming also that the relevant functions have the desirable properties to ensure unique interior solutions, the first order conditions that maximise Equation (1) subject to Equation (2) yield a set of demand equations for kxl health equations, conditioned on x_i, and l_i .

In its basic formulation, the health production framework will also contain an income constraint such that income equals expenditure on health[11]. In the present study however, we take the income constraint as given and assume constant health care costs[1]. These two assumptions follow because the analysis is based on choices made at a given point in time during which we assume limited variation in costs. Also, constant costs can be

reasonably assumed, especially where analysis employs cross-sectional data[12]. We employ cross sectional data in the present study.

Econometric Estimation

The framework in Equations (1) and (2) reflects the circumstances of the individual and health-related factors influencing health. Thus, having categorised the different health outcomes into a single individual-level variable, and for a random sample from the population, the set of equations in (2) can be estimated as a multinomial logit (mlogit) model.

Thus, for k categories of health outcomes (k=0, 1, 2, …..,K), the econometric implementation requires estimation of a set of k-1 health demand equations, one for each category relative to the reference category. Let k=0 be the reference category (i.e. individuals reporting no health problem or disease), then, for k = 2, ….., K;

$$\frac{P(h_i = K)}{P(h_i = 1)} = \alpha_k + \sum_{m=1}^{m} \beta_{1,km} x_{ik}\, \beta_{2,i} = S_{ki} \qquad (3)$$

Where j is a vector of parameters (j=1,2) to be estimated including, corresponding to each health outcome. The probabilities associated with Equation (3) can be stated for the reference category (k = 0);

$$P(h_i = K) = \frac{1}{1 + \sum_{g=k}^{M} exp\,(S_{gi})} \qquad (4)$$

and for k = 1, 2,….K;

$$P(h_i = K) = \frac{exp\,(S_{ki})}{1 + \sum_{g=k}^{M} exp\,(S_{gi})} \qquad (5)$$

Equations (4) and (5) indicate that the exponential value of a coefficient is interpreted as the relative risk for a one unit change in the risk of the health outcome relative to the base health state. In line with the stated objectives of this study, we feature the role of gender (amongst the x_i vector of determinants) as a key factor mediating part of the causality in the health-education relationship.

Data

Data for this analysis are obtained from the South African General Household Survey (SAGHS). The main covariates in the model are related to measures of health, age, education income and medical care. Descriptive statistics of all variables are presented for all respondents (Table 1). The main variables are discussed below.

Health:

The GHS asks respondents whether they had any illness or injury during the past month preceding the interview. Respondents can either say yes or no; and if they say yes, they are asked to provide more details about the type of illness or injury. A list of illness/injuries is presented, which includes the following; flu, diarrhoea, severe trauma, Tuberculosis or severe cough, alcohol and/or drug abuse, depression or mental illness, diabetes, high/low blood pressure, HIV/AIDS, other sexually transmitted diseases and other illness or injury. We therefore created a categorical dependent variable with twelve categories, one representing no illness or injury and the remaining eleven representing the illnesses/injuries reported above. We therefore model the likelihood of an illness or injury compared to no illness or injury (the base category).

Education:

The GHS asks respondents to state the highest level of education that they have completed. This excludes any ongoing educational enrolments. We redefine their responses into four categories; none, primary, secondary and tertiary. We would expect a positive relationship between the level of education and respondents' health. We are only interested in the level of educational attainment, for the purpose of this analysis. It is common in the literature to also find the use of the number of years of schooling as a measure of educational attainment.

Income:

The measure of income used in this paper is an index of socioeconomic factors meant to capture the value of respondents' assets. This index was derived using principal components analysis (PCA), applied to eight indicators of socioeconomic status: type of dwelling, main source of water, type of Toilet facility, connection to electricity, ownership of a vehicle, ownership of a telephone, ownership of a TV, and ownership of a radio.

These variables are transformed into dummy variables (1 for success, or ownership of higher level of assets as in the case of toilet, dwelling and main source of water). The index generated from the PCA exercise mirrors the main underlying driver in the variation of all these variables across all households. Thus, the index is a measure of socio-economic status (asset index), higher values indicating better socioeconomic circumstances. We would expect a positive effect of asset index on respondents' health production.

Medical care:

Respondents were asked whether they sought (or

had) medical care as a result of the illness or injury, and where they had the medical care (if they did). Their responses are grouped into three categories; no care (if they had no medical care), public (if they had care in a public or government facility) and private (if they used a private facility). Apart from their medical condition (as well as the severity of illness or injury), individuals make judgements about whether to seek medical care or not, depending on so many factors including income and other actors that determine access. A positive association is expected between medical care and health production.

Results

The overall sample consists of N=37,208 observations, comprising N=11,648; N=12,522; and N=13,038 observations for GHS 2002, 2006, and 2008, respectively. Descriptive statistics of (dependent and independent) variables are presented in Table 1, covering the entire sample of respondents. A majority of respondents reported having no illness or injury, while a majority of those who did report an illness or injury had flu. The proportion of those reporting no illness or injury reduced over time (from 88.25 percent in 2002 to 87.83 percent in 2006 and then to 85.49 percent in 2008). The distribution of respondents by ethnic groups reflects actual South African population proportions, with Africans constituting the greatest proportion. About 20 percent of respondents had no formal education in any survey year, while at least 4 percent had completed tertiary education. While about a tenth of respondents had medical aid, at least a quarter of respondents had no medical care in any one survey year. The average respondent age was about 27 years and the average asset index was about zero.

Table 1: Descriptive Statistics of Variables for all Respondents

Variable	2002	2006	2008
	Mean (sd) or proportion		
Illness types:			
None	88.25	87.83	85.49
Flu	5.12	5.69	6.56
Diarrhoea	0.35	0.46	0.54
Severe trauma	0.28	0.30	0.27
Tuberculosis or severe cough	0.52	0.62	0.66
Alcohol or drug abuse	0.03	0.04	0.04
Depression or mental illness	0.37	0.34	0.33
Diabetes	0.37	0.43	0.45
High/low blood pressure	1.42	1.30	1.68
HIV/AIDS	0.04	0.17	0.26
Other STDs	0.02	0.04	0.05
Other illness or injury	3.23	2.78	3.67
Gender (female)	52.54	53.22	53.14
Ethnicity:			
African	77.88	78.94	82.08
Coloured	11.35	13.48	10.67
Indian	2.42	1.78	2.36
White	8.36	5.80	4.89
Marital status (married)	27.26	25.32	25.16
Education level:			
None	20.19	19.88	19.08
Primary	36.25	35.71	33.50
Secondary	38.05	39.97	41.62
Tertiary	5.51	4.44	5.80
Medical aid (yes)	14.63	10.83	12.46
Medical care use:			
None	34.00	28.41	26.76
Public	47.27	55.37	51.01
Private	18.73	16.22	22.23
Age (years)	27.31 (19.75)	27.52 (19.91)	27.69 (20.10)
Assets index	-0.06 (1.86)	-0.74 (1.47)	0.02 (1.68)

Table 2 compares differences in reported illness between males and females for 2002, 2006 and 2008. For example, a greater proportion of males reported having no illness or injury one month prior to the survey. There were also gender variations in reported illness profile in the three survey years. For example in 2002, while greater proportions of males were associated with illnesses such as severe trauma, tuberculosis, alcohol and drug abuse, high or low blood pressure, females were more likely to suffer from flu, diabetes and other illnesses not listed. These findings were also consistent in the later survey years (That is, 2006 and 2008).

Greater proportions of female respondents reported having no formal education compared to males in all the three survey years. There were hardly any gender differences between those respondents who had no medical care over the years, despite slightly more males having medical aid compared to females. Amongst those who did, more females had public care while more males had private care. The estimation results are presented in the next subsection.

Table 2: Descriptive Statistics of Variables by Gender

Variable	**2002**		**2006**		**2008**	
	Female	Male	Female	Male	Female	Male
	Proportion or Mean (standard deviation)					
Illness types:						
None	87.21	89.40	86.60	89.23	83.94	87.24
Flu	5.38	4.83	6.06	5.27	6.83	6.25
Diarrhoea	0.35	0.35	0.50	0.41	0.60	0.46
Severe trauma	0.25	0.30	0.21	0.40	0.21	0.34
Tuberculosis or severe cough	0.40	0.65	0.53	0.73	0.58	0.76
Alcohol or drug abuse	0.01	0.05	0.04	0.04	0.02	0.07
Depression or mental illness	0.36	0.37	0.34	0.34	0.33	0.33
Diabetes	0.43	0.30	0.55	0.30	0.52	0.38
High/low blood pressure	1.99	0.80	1.86	0.66	2.43	0.83
HIV/AIDS	0.04	0.03	0.22	0.11	0.34	0.18
Other STDs	0.02	0.03	0.04	0.04	0.05	0.06
Other illness or injury	3.54	2.90	3.06	2.47	4.17	3.10
Ethnicity:						
African	78.06	77.66	79.53	78.26	82.52	81.58
Coloured	11.51	11.18	13.25	13.75	10.59	10.76
Indian	2.36	2.49	1.69	1.87	2.31	2.42
White	8.07	8.68	5.52	6.12	4.57	5.24
Marital status (married)	26.35	28.27	24.81	25.91	24.72	25.67
Education level:						
None	20.85	19.46	20.57	19.09	19.76	18.30
Primary	34.88	37.78	34.67	36.89	32.51	34.63
Secondary	38.83	37.18	40.35	39.55	41.97	41.22
Tertiary	5.44	5.58	4.42	4.48	5.75	5.86
Medical aid (yes)	14.05	15.28	10.53	11.17	12.01	12.97
Medical care use:						
None	33.36	34.85	28.37	28.40	26.69	26.86
Public	48.57	45.53	56.79	53.40	52.59	48.76
Private	18.07	19.61	14.85	18.20	20.73	24.38
Age (years)	28.50 (20.34)	25.99 (18.99)	28.86 (20.49)	26.00 (19.12)	29.20 (20.76)	25.98 (19.19)
Assets index	-0.08 (1.86)	-0.04 (1.86)	-0.77 (1.47))	-0.72 (1.47)	0.01 (1.68)	0.04 (1.69)

Regression Results

Table 3 presents the results of the mlogit estimation described in Section 2.3. The model was estimated separately for 2002, 2006 and 2008. All models were estimated using STATA v.11. The likelihood ratio (Chi2) tests for the 2002, 2006, and 2008 models show that all the regression models were statistically significant at the 1 percent level, with $\chi^2_{(176)} = 4532.04$, p-value = 0.0; $\chi^2_{(176)} = 4593.5$ p-value = 0.01; and $\chi^2_{(176)} = 5385.4$, p-value = 0.01, respectively. Results are presented only for statistically significant variables. The full results are available from the authors upon request.

Table 3: Multinomial Logit Estimation Results of the Determinants of Health

	2002	2006	2008
	Coefficient (Standard error) [#]		
Flu [##]			
Age	-0.020 (0.000)**	-0.028 (0.000)**	
Coloured (base is African)	0.808 (0.062)*		
Public care (base is no care)	-0.444 (0.085)*	-0.714 (0.011)*	-0.940 (0.003)**
Diarrhoea			
Male*primary			-0.815 (0.098)*
Male*secondary			-1.286 (0.008)**
Female*primary education	-0.943 (0.034)*		
Female*secondary			-1.071 (0.016)*
Female*tertiary			-1.856 (0.010)*
Age	-0.019 (0.002)**	-0.037 (0.000)**	-0.013 (0.037)*
Asset index	-0.298 (0.000)**		-0.298 (0.000)**
Public care (base is no care)		-0.560 (0.066)*	-0.786 (0.019)*
Private care (base is no care)	-0.621 (0.066)*		-0.891 (0.011)*
Severe trauma			
Male*primary		1.187 (0.025)*	
Male*secondary		1.041 (0.032)*	1.048 (0.051)*
Female*no education		-0.941 (0.095)*	
Age			0.015 (0.032)*
Asset index	-0.166 (0.032)*		
Coloured (base is African)	1.262 (0.007)**		
Private care (base is no care)			-1.425 (0.000)**
TB or severe cough			
Female*no education	-0.851 (0.079)*	-0.790 (0.089)*	-0.894 (0.062)*
Female*primary	-0.822 (0.056)*	-0.733 (0.071)*	
Female*secondary			-0.882 (0.046)*
Female*tertiary			-1.396 (0.054)*
Age	0.019 (0.001)**		0.025 (0.000)**
Asset index	-0.309 (0.000)**	-0.186 (0.040)*	-0.264 (0.001)**
Indian (base is African)			-1.380 (0.063)*
White (base is African)	-2.148 (0.009)**	-1.446 (0.025)*	-2.474 (0.027)*
Medical aid			-1.097 (0.017)*
Private care (base is no care)			-1.272 (0.001)**
Alcohol or drug abuse			
Female*no education	-2.028 (0.032)*		
Female*primary	-1.898 (0.020)*		
Female*secondary	-2.566 (0.028)*		
Age	0.036 (0.001)**		0.028 (0.006)**
Asset index		-0.308 (0.053)*	
Married	-1.284 (0.022)*		

Notes: *# Robust standard errors in parentheses, with the level of statistical significance: *** p<0.01, ** p<0.05, *p<0.1; ##All the illness categories are relative to individuals with 'no illness/injury'.*

Table 3: Multinomial Logit Estimation Results of the Determinants of Health (continued-1)

	2002	2006	2008
	Coefficient (Standard error) [#]		
Depression or mental illness			
Female*no education			-0.894 (0.080)*
Female*primary	-0.858 (0.059)*	-0.730 (0.094)*	
Female*secondary education			-0.882 (0.060)*
Age	0.019 (0.001)**		0.033 (0.000)**
Coloured (base is African)	0.971 (0.037)*		
White (base is African)		-0.915 (0.087)*	
Married	-0.688 (0.011)*	-0.622 (0.020)*	-0.788 (0.007)**
Public care (base is no care)	0.522 (0.080)*		
Private care (base is no care)			-0.908 (0.016)*
Diabetes			
Male*primary		1.058 (0.050)*	
Male*secondary	1.286 (0.020)*		
Female*no education		1.032 (0.037)*	
Female*primary	1.126 (0.029)*	0.832 (0.062)*	
Female*secondary	1.154 (0.029)*		
Age	0.052 (0.000)**	0.035 (0.000)**	0.070 (0.000)**
Asset index		0.267 (0.005)**	
Coloured (base is African)	1.109 (0.016)*		
Private care (base is no care)	-0.879 (0.014)*		-1.677 (0.000)**
High/low blood pressure			
Male*primary		0.866 (0.083)*	
Female*no education		1.044 (0.021)*	
Female*primary	0.810 (0.056)*	0.958 (0.018)*	1.182 (0.014)*
Female*secondary	1.052 (0.015)*	0.675 (0.097)*	
Age	0.060 (0.000)**	0.046 (0.000)**	0.072 (0.000)**
Asset index		0.179 (0.043)*	
Coloured (base is African)	1.161 (0.008)**		
White (base is African)		-0.986 (0.037)*	-1.075 (0.035)*
Married		0.438 (0.065)*	
Private care (base is no care)	-0.651 (0.035)*		-1.198 (0.000)**
HIV/AIDS			
Male*primary		1.222 (0.069)*	
Age			0.022 (0.001)**
Asset index			-0.159 (0.070)*
Medical aid		-1.294 (0.072)*	
Public care (base is no care)		0.789 (0.043)*	
Private care (base is no care)			-1.677 (0.000)**
Other STDs			
Male*secondary	2.276 (0.047)*		
Female*no education			-1.396 (0.097)*
Asset index	-0.370 (0.012)*		
Public care (base is no care)			-0.859 (0.074)*
Private care (base is no care)	-1.947 (0.090)*		-2.419 (0.001)**

Table 3: Multinomial Logit Estimation Results of the Determinants of Health (continued-2)

	2002	2006	2008

	Coefficient (Standard error) [#]		
Other illness or injury			
Age	0.010 (0.058)*		0.024 (0.000)**
Asset index	-0.149 (0.025)*		
Coloured (base is African)	0.805 (0.064)*		
Indian (base is African)			-1.004 (0.072)*
Public care (base is no care)			-0.654 (0.037)*
Private care (base is no care)	-0.724 (0.014)*		-1.435 (0.000)**
Sample	11648	12522	13038
Likelihood Ratio test Chi2 (Prob>chi2)	4532 (<0.01)**	4593.5 (<0.01)**	5385.4 (<0.01)**
Pseudo R^2	0.1220	0.1114	0.1269
Log likelihood	-16311.073	-18321.63	-18523.482

There were clear significant effects of the interaction between gender and level of education on demand for health. Results for 2002 showed that females with primary education were significantly associated with a reduced likelihood of reporting diarrhoea, TB or severe cough, alcohol or drug abuse, depression or mental illness, diabetes, and high/low blood pressure compared to males with a similar level of education. In addition, females with secondary education were associated with reduced likelihood of reporting diarrhoea, TB or severe cough, alcohol or drug abuse, diabetes, and high/low blood pressure. On the other hand, males with secondary education were significantly more likely to report diabetes and other sexually transmitted diseases.

Results for 2006 also show significant gender differences in reported illness or injury. Females

with primary education were associated with fewer reports of Tuberculosis (TB) or severe cough, depression or mental illness, diabetes, and high or low blood pressure. They were significantly associated with reduced high or low blood pressure if they had secondary education. In 2008, female respondents were associated with significant reductions in the likelihood of reporting high blood pressure if they had primary education; and with diarrhoea and TB or severe cough, depression or mental illness if they had secondary education. Those who had tertiary education were associated with less diarrhoea, and TB or severe cough, compared to males.

Female respondents with no formal education were also significantly associated with a reduced likelihood of illness or injury compared to males. For example, they were associated with significantly

reduced likelihoods of severe trauma, TB or severe cough, alcohol or drug abuse, depression or mental illness, diabetes, high or low blood pressure and other sexually transmitted diseases.

In addition to gender differences in the demand for health, there were also significant effects of age. There were significant positive effects of age on a majority of illness and injury types; older respondents were associated with significantly more illness than younger ones (there were significant positive associations between age and severe trauma, TB or severe cough, alcohol or drug abuse, depression or mental illness, diabetes, high or low blood pressure, HIV/AIDS and other illnesses and injuries). There were however negative associations between age and flu and also between age and diarrhoea.

The effects of our income measure (asset index) on reported illness or injury were generally negative, suggesting that income had a positive effect on health. The asset index was significantly associated with reductions in diarrhoea (2002 and 2008), severe trauma (2002), TB or severe cough ((2002, 2006 and 2008), alcohol or drug abuse (2006), HIV/AIDS (2008), other sexually transmitted diseases (2002) and other illness or injury (2002). However, it was also significantly associated with increases in diabetes and high/low blood pressure (both in 2006). This result may be reflecting the unhealthy lifestyles prevalent amongst the more affluent.

There were also significant effects of medical care on reported illness. Respondents who had public care were associated with a reduced likelihood of reporting flu, other sexually transmitted diseases and other illnesses or injuries. Those who had private care were significantly associated with lower reported diarrhoea, severe trauma, TB or severe cough, depression or mental illness, diabetes, high/low blood pressure, HIV/AIDS, other sexually transmitted diseases and other illnesses or injuries. On the other hand, there were significant positive

associations between public care on the one hand, and depression and HIV/AIDS on the other hand. Generally, there were more statistically significant effects of private care over public care. The results here appear to be reflecting the differences in the profiles between those who sought care in public and private facilities and the case mix or profile of care sought for various illnesses and diseases in public and private facilities.

Discussion

In this study, we explored the view that there are gender differences in the way in which education contributes to health production. We featured the role of gender differences in health-education relationship, by analysing associations between respondents' characteristics, education, income and medical care, and their reported illness or injury, using a Grossman health production model. The Grossman model views the individual as both a consumer and a producer of the commodity health. When individuals are faced with limited choices such as education attainment, they will be unable to create awareness of health-improving activities and enables the more efficient transform of inputs into better health outcomes.

The analysis in this paper draws is important for policies aimed at achieving the MDGs, as it highlights the importance of the link between education and health, within the context of South Africa. Such an understanding is central to health improvement, attainment of gender equality and gender empowerment. The motivation for this study arose from the need to understand the implications of science, technology, and innovation for achieving the MDGs. The results in this analysis showed statistically significant gender differences in the role of education on reported illness or injury, and suggest that females were better producers of health compared to males. Other results reflect finding from the general literature on the demand for health. There were significant positive effects of age on illness, alongside negative effects of income and medical care. However, private medical care was more significantly assisted with reduction in reported illness compared to public care.

Despite physiological differences between men and women, which may have implications for differences in health, our results highlight the importance of education in driving further differences. Consequently, this also makes a case for supporting policies aimed at improving access to education among females, and to greater gender equality for improved development the 2012 World Development Report[14] makes a strong case for gender equality as a vital ingredient in the equation for economic growth; the results in this paper support that argument in that Report.

In terms of policy, the results suggest a mechanism by which the MDGs, and indeed sustainable development in health, are achievable. Firstly, policies or interventions designed to provide greater opportunities to educate females are encouraged, as education has greater impact in their health production. Also, such interventions will also improve gender equality and women empowerment. Secondly, there was evidence of differences in case mix between those who sought care in public and private facilities. This suggests either that private medical care may currently be more effective in curing illness or respondents with specific illness are more likely to seek private care rather than public care.

As in previous studies, the present study is not without limitations. A major limitation of this analysis is that self-reported health may not reflect actual health, hence it was treated a latent, unobservable variable in the analysis Also, our results only explain between 11 and 13 percent variations in reported illness across respondents, hence there exist large unexplained variations. However, our models have captured the effects of the main determinants of health, namely education, medical care and income, given the covariates available to us at the time of analysis. In addition, we recognise that our analysis was based on cross-sectional data, which limits the extent to which causality can be inferred. The use of longitudinal or panel data to explore similar research questions can improve the analysis greatly.

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