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DIABETES MANAGEMENT: THE ASSOCIATION OF WEALTH, SPENDING AND PERFORMANCE IN LATIN AMERICAN AND CARIBBEAN COUNTRIES

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ABSTRACT

The aim of this paper is to assess the performance and outcome of health systems in managing diabetes in Latin American and Caribbean countries, with a specific focus on the influence of wealth and expenditure on outcome indicators and cost-efficiency. Using publicly available economic and health data for 33 countries, the results show an inverse relationship between wealth, diabetes health spending and NCD indicator. Countries with higher levels of capital and higher expenditure did not necessarily have better outcomes than countries with lower expenditure as theoretically postulated. Policy implications from this study would be on the need for the national health services organization and other regional socially-led bodies to institute cost-effective health management strategies within a firmer regulatory environment context. Moreover, rising diabetes-related health cost would hamper one nation's ability to sustain wealth and economic growth.

Keywords: Diabetes Management; Economic Growth; Health Care Costs; Health Systems; Performance

1. INTRODUCTION

Latin America and the Caribbean are now thought to need an epidemic response to Chronic Non-communicable Diseases (CNCDs), given the destabilizing threat on developing economies. The investment climate for health in low and middle-income countries (LMICs) is comparatively minimal, yet Drechsler and Jütting (2005) reveal an alarming proportion of global disease burden by these LMICs at 93%.

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Theordore (2011) notes that a country's financial vulnerability is occasioned by the nature of CNCDs which slowly diminishes the quality of life over a long span and therefore, the author suggest more of a focus on a managerial response the is more sustained and committed that that of other management strategies. The challenge of prevalence is outweighed by rising incidence in tandem with a genetic predisposition to diabetes. Particularly, the North America and Caribbean Region is noted as having the second highest comparative prevalence of diabetes, while the Caribbean records prevalence above global averages (IDF, 2011).

Particularly, Trinidad and Tobago (T&T), of which the study gives focus, is known to be one of the richest countries in CARICOM region, its economy being driven by a buoyant energy sector. Its Mean Diabetes-Related Expenditure per person noted at US$668, was 180% higher than Jamaica: yet its diseased population as of 2010 was estimated at close to 70% of Jamaica's.

West Indian researchers and other have focused broadly on the economic impact of NDCs (Theordore, 2011); information system deficiencies (Cunningham-Myrie, Reid and Forrester, 2008); economic burden of diabetes mellitus (Barcelo et al, 2003), while several narratives calls for the reprioritization of policy support towards upstream interventions (Hospedales et al., 2011). However, little has been done to evaluate and compare the optimization of investments, and further how wealth and/ or the levels of expenditure in diabetes program influence health.

Budgetary constraints, democratic and global financial pressures will demand health system managers to respond with effective and efficient solutions, towards generating positive returns. It is widely accepted therefore that the degrees of cost-efficiencies and effectiveness experienced by countries, despite investment per capita vary diversely due to health system organization, resource allocation and maximization strategies (Gani et al, 2008). However, health system typology in the region sees for the most part government provision and / or financing of health with mixed insurance schemes and a disproportionate focus on acute care. In the short-term, the nation's proximal approach achieves success in the management of diabetes but not incidence (Bobb et al, 2008). Similarly, researchers submit that:

> "…medicine might be winning the battle of glucose control, but is losing the war against diabetes. Though research publications represent great progress in the understanding of diabetes and the ability to lower concentrations of blood glucose, there is a glaring absence: no research on lifestyle interventions to prevent or reverse diabetes." (Lancet, 2010, p. 2193).

All these would suggest that there could be a defect in the preventive role amid sound success in curing the disease.

The overarching aim of this study is to assess the nature of the association between wealth, diabetes health-related spending and performance amidst health system regionally. It focuses primarily on appraising the influences of wealth and expenditure on cost-efficiency and outcome; and comparing the performance among select nations. To this end, the appraisal is done across 33 countries Latin American and Caribbean countries.

Therefore, the fundamental question: Is there any association between wealth, health expenditure for diabetes and performance indicators? The quantitative method is utilized

based on the secondary data of health measure and financial estimates produced by several international research bodies. The results show an inverse relationship between wealth, diabetes health spending and NCD indicator. Countries with higher levels of capital and higher expenditure did not necessarily have better outcomes than countries with lower expenditure as theoretically postulated. Policy implications from this study would be on the need for the national health services organization and other regional socially-led bodies to institute cost-effective health management strategies within a firmer regulatory environment context. Moreover, rising diabetes-related health cost would hamper one nation's ability to sustain wealth and economic growth.

The remainder of this paper is organized as follows. Section 2 explores the theoretical foundations in relation to health care systems, cost management and performance. Section 3 explains the research methods and the data used for this study. Sections 4 and 5 present the findings and the discussion, respectively. Section 6 concludes the paper.

2. LITERATURE REVIEW

2.1. Health Capital Theory and Disease Management

The seminal work of Grossman (1972) is an exploration of health demand, benched upon the health capital theory. It places emphasis on personal inputs and time, to produce an optimal health stock. This function of health production sees the efficient pursuit of individual and other variables, such as medical care; the utility of which contributes to health improvement, whereas, deprivation, lifestyle choices and aging contributes negatively to the health stock (Kverndokk, 2000).

Of interest is the link between the investment and consumption motive of healthcare (Leibowitz, 2004) where issues of constraint, preferences, income shifts and technological change influence the function. The central idea is that investment in healthcare should redound to improvements in health outcome. Therefore inputs like wealth, income and education should have been considered is assessing one's efficiency in producing health and reducing price of investment.

A similar economic premise stands in the disease management literature: investments in chronic care mitigate future costs associated with protracted chronic complications and enhance patient life. Through an integrated strategy devoted to population health and personal care, efficient management tempers the disease path. The success of this thrust rests on the availability of essential tools to include human capacity, institutional support, and ICT solutions. Such approach makes for an economically demanding proposal; improving population health being linked to increased investment throughout the system.

As per investments, later schools of thought advance that overtime, further investment will not redound to constant returns. Real-life phenomena now project a non-linear concave relationship between health spending and improvement, wherein marginal returns are assumed beyond optimal investment (Galama et al. 2012, p.2). This feature is predicated on the absence of sickness, degradation of health with time, and the increases in health costs, closer to death.

The theory of health capital has since advanced, with minor variations. Particularly, the family is placed as the deterministic agent treating with stochastic health loss or maintenance. In the extension of the model health utilization choices are not equitably taken within a family, but rather, investment follows a rate equilibrium of:

> "…marginal consumption benefits… [to that of] marginal net effective cost of health capital." (Jacobson, 2000, p.628)

Other theorists explore the inter-spousal correlations in health status (Wilson, 2001), and the impact of the health production function in times of conflict (Bolin, Jacobson and Lindgren, 2002a).

Slightly deviating from the seminal presentation, Bolin, Jacobson and Lindgren (2002b) add to the model, noting the investment incentives of the employer to interact with family health in the production function. This is in pursuit of employer-firm productivity and fulfillment of legal regulations, where the investment motive is placed outside the realms of private production.

Despite remodeling over thirty years, theoretical schools have remained silent on nontraditional perspectives. Health investment in LMICs, especially in the Caribbean region, is dominated by government investment and action (Alleyne and Sealy, 1992). Theorists have not yet considered the customization of theoretical models to such regimes, or include population-level inputs, where the government serves as a prime health producer (Leibowitz, 2004).

In a review of Health Economic Theories, Rutten et al (2001, p.856) note the literature and research dearth on LMICs and nuanced financial and health arrangements as per cost-efficiencies of interventions. Yet, what is known is the effect of economic development and wealth on population health occasioned in the wealth-health gradient, where countries with higher economic resources record better population health and longevity, while egalitarianism weakens the gradient (Semyonov, Lewin-Epstein and Maskileyson, 2013).

2.2. Public Finance Theory and X-efficiency

An extension of the health production function would be to consider the role of Public Finance in low and middle-income welfare regime. In theory, governments, as health producers, are incentivized to interact with families for reasons of national growth, productivity and security. The Public Finance Model, grounded in Musgrave's 1959 Theory of Public Finance, assumes that governments, in light of market failure, intervene in the market to secure equity, efficiency and facilitate risk sharing.

The public finance foundation have been framed on ethical justifications and often, these traditional offering are removed from economic reasoning (Hurley, 2001). Private markets are considered incapable of treating with the social goals and higher ends. Governments therefore acquire financial responsibility and bargaining rights to efficiently allocate shared public resources through a system of taxation and social security (Honore´ and Amy, 2007). Consequently, investment actions, becomes an institutional variable of population health.

Bolstered in progressivity is the concept of redistribution, where the economically strong offset the cost of commodities for the weak, through varied taxation. Aside, fiscal burden is

theorized as being progressively distributed, in which instance, limits are placed on the individual as it relates to accessing benefits. The theory suggests that spending and taxes are intuitively connected, and therefore, in valuating social investments, what is considered is the perception of burden and how it is distributed.

However, Auerbach (2009) explains that in the context of health care and social benefits, there is an anomaly, as taxation does not disqualify the non-worker or supply is not determined by degree of individual contribution. Thus, theorists suggest that, governments may become limited in shifting funds in changed social circumstances under fixed taxation schemes. Here, tax dedication is instituted a protection to overcome taxpayer skepticism; limit excesses for particular program based on competing social interest; or advance social agendas (Auerbach, 2009). Therefore the theory affirms that taxation mechanisms alter the level of spending and hinge on the institutional capacity to treat with crisis.

Moreover, one of the strong premises in public finance of healthcare is efficiency. One group of authors define technical efficiency as:

> "…producing maximum health outcomes…from available resources or minimizing the use of available resources to produce a given level of health outcome" (Kirigia et al, 2007, p. 19)

Consequently, the behaviour of cost as it pertains to managing chronic disease will see increases with prevalence and recurrent cost, because of pathophysiology. However, Reidpath and Allotey (2012) extend that less superior models or systems for disease management exist in LMICs as opposed to developed NHS. Public Finance Management therefore calls for balanced and comprehensive process that informs project prioritization, financial controls and resource use that secure 'value for money'.

Within nationalized institutional settings, the dynamics of management and how efficiency evolves is different and therefore subjected to different assessments. Christian and Crisp (2012) in evaluating the health sector of South Africa expound that despite increased priority by governments to enhance public financing of health, outcomes are suboptimal in the presence of X-inefficiency. They propose that inefficiencies are endogenous, and outcome, not solely a problem of dearth.

The ideas of X-efficiency began with Leibenstein's 1966 seminal postulations. He assessed the influence of efficiency on constraint, with particular attention to intuitional and human behaviour on performance. Agents are assumed to be 'non-maximizers', who influence institutional behaviour, based on intrinsic and extrinsic pressures. Therefore, decisions are 'satisficed' or balanced on the premise of bounded rationality. Motivational forces of 'constraint concern' and self-preservation are constantly at loggerheads. In the face of information asymmetry, and non-explicit institutional rules, the theory proffers that managers are forced into self-interpretative and discretionary norms of efficiency efforts, towards the principal-agent problem.

Further advise in the matter is that efforts of cost minimization and optimization is strongest with external pressures and the author further extends that:

> "…firms will not minimize cost for a given output unless competition or environmental elements force them to do so"…[X-inefficiency therefore suggests] "the excess of actual over minimum cost for a minimum output" (Leibenstein (1978, p.328)

Here, concern or attention for grasping opportunities, minimizing cost and mitigating losses are low.

One of the affirmations of the X-efficiency perspective is that government institutions are more predisposed to exacerbated inefficiencies in the absence of competition and pressure; and where there are large inert areas. Therefore, it is suggested that the personality and taste of management for 'constraint concern' in tandem with contextual economic pressures are deciding factors of how far management deviated from behaviours that maximize efficiency (Leibenstein, 1978).

One could argue that politics can also bear on public finance efficiencies. In his reflection, Auerbach (2009) agrees that negative outcomes of public finance are induced by structural inhibitions. The theorist illustrates on the barriers to public finance efficiencies:

> "…misalignment of incentives, corruption, rent-seeking, concentration of benefits, imperfect information." (Auerbach, 2009, p.2)

These, according to the author, corrupt the principles of public finance; through persistent neglect of economic prescriptions.

Absent in the health economic theory is the way in which choices and restrictions surrounding dominant public finance have impacted on health production and capital under conditions of exacerbated disease prevalence. By and large, efficiency theories suggest solutions that are more conducive and embraced in private environments with little consideration of the ingrained cultural, traditional and political strongholds. Theoretical exploration is necessitated and the strong message nevertheless, is that public finance and public system reform is critical to overturning inefficiencies and deriving more optimal levels of outcome.

2.3. Research Evidence

2.3.1. Increased Health Spending and Health Outcome

Empirical evidence on the association between health spending and outcome has largely been considered inconclusive and inconsistent. However with theoretical refinement, researchers have treated with disentanglement and methodological problems. Early research showed no association between investments and outcomes.

In explaining the differences in age-specific mortality rate Cochrane, Leger and Moore (1978) conducted a regression analysis across 18 developed countries, using environmental; demographic; economic; dietary and health facility indices, drawn from 1969 – 1971 datasets. Inclusion criteria, was based on the GNP US$2,000 per capital with minimal exceptions. While there were positive associations between resource inputs; (doctors, nurses and nutrition), in younger ages, there was a negative association between financial inputs and mortality except in age groups of 5 – 24 years. Financial interventions of public funds were consistently negatively associated with mortality from 15 – 34 years. Apart from the limitation of national homogeneity, the majority of the countries considered were 'Western', with wealth well above subsistence level.

Outside of the Western sample bias, evaluating foreign direct investment in health, as a development input, Wimberly (1999, p.75) found a negative and harmful influence of foreign

companies infiltration on mortality; an effect which escalated over time. 63 third world countries were analyzed to test the relationship between investment dependence and mortality, using UN 1986 datasets for infant mortality, and life expectancy from 1970-75 and 1975-80. Similarly, increases in MNC investment did not redound to meaningful and significant effects on infant mortality. Other variables may be at play.

Countless older studies present results of spurious, weak or inconsistent correlations between health investment and outcome particular to 'avoidable mortality' (Mackenbach, Bouvier-Colle and Jougla, 1990; Sankrithi, Emanuel and Van Belle, 1991; Clarke, Farmer and Miller, 1994; Matteson, Burr and Marshall, 1998).

Young (2001) also showed where increased investment in physician per capita presented no significant evidence of health outcome improvement. Looking at 1980 -1990 rural to urban/industrialized migration in Japan, Europe and the USA, a regression analysis was utilized, having controlled income. However, he notes the theoretical counter-intuitiveness in the function of investments in modern technology and medicine to not enhance health. Analytically, there seemed to be a challenge in considering that the greatest stock of health is experienced during adulthood and gradually declines. Therefore, research focus benched in instances of population illnesses and risks can prove intuitive.

Understanding the protracted behaviour of investments and returns, Gravelle and Backhouse (1987, p.435) critique that past regression analysis failed to consider that current inputs may not be the only plausible explanation for mortality rates but past inputs as well. They suggest therefore, that the production function is not simplistic. Accordingly, the foundational replications of Cochrane et al., according to Gravelle and Backhouse (1987) were statistically flawed with issues of variable selection bias, inferential and analytical misinterpretation and time insensitivity and incongruence.

Consequently, researchers have sought other ways to measure outcome. Luce et al. (2006) consider Return on Investment in USA from 1980 – 2000, looking for longer-termed benefits. The researchers drew from previous work that emphasized cost-benefit. Four specific health treatment conditions were assessed (coronary conditions, stroke, diabetes (type 2) and breast cancer); as opposed to infant mortality and life expectancy. A three prong triangularly approach was utilized to estimate returns: generalized healthcare; specialized treatment of four cases mentioned and; dramatic innovations in the four groups. Health gains were monetized based on marginal costs of each dollar spent. It was found that while spending increased concomitantly, there were quantifiable gains to every additional dollar spent in specialized cases reported as QALY measurements. It concluded that there is no strong collective theoretical agreement that proves otherwise on the effects of health spending on improvement.

Concurrently, researchers focused on the returns of specific-health related innovations and interventions. For example, Klonoff and Schwartz (2000) classified interventions by their economic impact. 17 known diabetes interventions conducted between 1984 and 1997 were ranked on a scale of five (5) to include ranging from clearly 'cost-saving' to 'unclear'. A literature review was conducted to stratify the economic research by their relative ranges of outcomes. Ranges were based on modelling analysis of adjusted life years and value spent per life year, and comparing status of intervention and non-intervention patients. Subsequently, Goetzel et al. (2005, p. 10) posit that most of these studies of the 70's and 80's, although they bear positive results, should be treated with caution as non-experimental methods were utilized.

It is agreed that health economics present very complex challenges; and therefore striving for explicitness makes for cumbersome theoretical models (Martin, Rice and Smith, 2009, p. 12). As opposed to individualized intervention, Martin, Rice and Smith (2008) found a way to address health spending comprehensively from the perspective of a system or institution. Looking at 295 English primary care thrusts, the researchers assessed the programme budgeting features and created a theoretical and empirical model for cancer and circulatory problems across the varying levels of health care, to forge a link between healthcare spending and outcome.

Two models were formulated for the programmes to demonstrate the production function, by which fixed budgetary allocation is made for the programmes of care; one as an expenditure function bearing in mind competing costs; and the other a function of outcome, based on need in fiscal 2003/ 2004 and 2004/ 2005. The methodology also involved the formulation of an equation to estimate the saving in life years for each disease programme. The result of this was controlled and customized budgeting reform estimations. There was a positive correlation with death rate and expenditure for cancer and need, as opposed to the non-cancer death rate. Particular to households, it was found that based on need, lone pensioners and persons with unpaid care, demonstrated a greater need and increased care in tandem with compliance with regime, demonstrating fewer circulatory deaths. Circulatory care demonstrated a higher life year yields than cancer, the former proving cheaper by £5,100.

In a later study, Martin, Rice and Smith (2009) extended the modelling to five other programs of care. For diabetes, it was found that:

> "a 1 per cent increase in diabetes expenditure per head – which was £17.60 in 2006/07 – leads to a 1.648 per cent reduction in YLL (all things being equal...implies that one extra life year would cost £26,429" (Martin, Rice and Smith, 2009, p.39).

Overall, the evidence, which links increased health spending to health outcome, is most dominant for industrialized nations with organized accounting practices. Econometric modelling proposals and appropriate measurements are still to be seen for LMIC arrangements. Moreover, beyond competing financial interests, is the limited theoretical and empirical evidence for the behavior of health production functions under circumstances of financial crisis and underdevelopment.

2.3.2. Public Health Finance Model: Inhibitions and Successes

Comprehensive empirical evidence on the tenets of the public finance theory is minimal. Focus on the theory is devout to expository arguments and advancement of theory. However, research has been conducted on individual elements and concepts of public finance as it pertains to the efficiency of public financing of health and equity agendas.

A clear theme is that in LMICs, with most systems being socially oriented, there is a challenge to ensure equity and reducing inequality in health as purposed in the public finance model. Ataguba and Di McIntyre (2012) note that literature on equity financing and universalizing health care is limited.

Mills et al. (2012) found varying levels of progressivity in three African countries; South Africa, Tanzania and Ghana. The authors found that while mechanism were both progressive and covered by direct taxation in all three countries the burden of illness was greatly

centralized among the lower-income groups although the service distribution benefits favored to a greater degree society's affluent. The authors relied heavily on secondary data from a recent national survey as per the catastrophic effects of financing health. Data was triangulated on revenue estimates and tax data. Primary data was derived from a household survey 2008 to capture rates of service usage, in tandem with focus groups and interviews, to explain further complexity of the quantitative data. There is however conflict with the varying sample sizes used between both primary and secondary data sources.

From another vantage, Buckley et al. (2012) developed a theoretical model to assess the effects of public, private and mixed financing of health. Particular to the public mechanism, Buckley et al (2012) laboratory experiment of 'Public-financing-only' behavior in the model, found that market prices were higher for insurance allocation rules for mixed financing than public financing. While there was a greater willingness to pay for private insurance by participants, the data suggested that the mixed system presented a catastrophic financial and health inequality effect and regressive outcomes for poorer classes of individuals.

Importantly, in regards to budget constraints proposed by the public finance model, Buckley et al. (2012) theoretic model shows that when testing increase public budget and effect on healthcare, an unexpected and opposite result is observed. The public insurer did not move to increasing offering and accessibility, but rather encouraged the ensuing of competition between private and public insurers, resulting in higher market prices. While, the laboratory experiment was derived form 10 participants over 32 sessions, the authors warn that the results were not based on actual behavioral responses but rather were deduced from mathematical calculations. Such begs the question of the transferability and practical relevance to a real life setting.

Looking qualitatively at the motivations of managers in South Africa's public systems, Christian and Crisp (2012) share insight into the reason for weak 'constraint concern' in the primary healthcare and district hospitals. They note it as coming from management inefficiencies and lack of qualification, support and requisite acumen to drive reform; the absence of institutional support which encourage 'sluggish' decision making and weak leadership; and the prevalence of incomplete contracts to explicitly guide operations. However, the research presents severe limitations, one of which includes the reliance of secondary research and literature from private sector globally with minimal presentation of examples in South Africa, geared at presenting a sound evidence-based platform for decision-making.

As per the progressivity of taxation across jurisdiction in the US, Honore´ et al (2004) found significant correlations between taxes per capita and high performance levels of 10 essential public health services in the US. A Pearson correlation analysis was adopted to evaluate annual financial data from 50 local health departments, US 1997 census data and HIS systems for mortality. Notably, higher taxes were more positively correlated with performance than other financial inputs for a majority of health services, where taxes were as much as 38% higher in high performance jurisdictions. A limitation of the study however, was the inability to present multiple correlations for taxes and public spending for the services in the absence of standardized data. Yet the results are credible for that which it examined.

In assessing the productivity and technical efficiency of 86 nationalized hospitals of varying sizes in three provinces in South Africa, Sere, McIntyre and Addison (2001) found that high degrees of inefficiency among hospitals this being 87 per cent of hospitals. Using an efficiency frontier by Data Envelopment Analysis on input such as 'labor, capital and

supplies' and intermediate output of treatment, R&D and knowledge transfer, such inefficiently run public hospitals exceeded optimization of resource use by 35.1 0 46.8 per cent, with smaller and less complex hospitals demonstrating highest technical and scale efficiency levels. Significant proportions of more complex and larger hospitals displayed suboptimal output. One of the drawbacks of the research as the authors admit, is the fact that the health outcomes (health status and improvement), as strategic and meaningful assessment of efficiency, could not be explored because of systemic 'practical difficulties'.

However, on a positive note, Wong et al (2012) compared Financing Systems of community health centers (CHC) in six cities of China, to assess the implication of system on outcome for hypertension. By way of binary logistic regression analysis, it was revealed that patients in Government funded CHC were demonstrated a greater likelihood of optimizing BP control than that of privately-funded CHC regardless of the presence of antihypertensive drugs prescriptions. Treatment and control rates were significantly poorer for private funded CHC as well. This study was conducted in 2010 and drew from chronic disease computerized records in the six cities and multi-stage cluster sampling of registered patients participated in previous health assessment survey.

However, the research was limited by sample size modesty as well as the use of one health indicator and one CNCD as a measure of efficiency, as opposed to a comprehensive look at lifestyle diseases and longer-termed outcomes. Similar positive results in health outcome and efficiencies exist for reformed public finance systems in transition economies like that of Mexico, Columbia and Thailand (Hu et al, 2008).

While a great degree of efficiency issues exists for LMIC, outcome of public finance of health in more developed nation NHS presents similar challenges. The difference is that NHSs in developed countries have advanced management system to treat better with outcome and cost than in LMICs. Nicholson and Roderick (2007) explain that renal services NHS in England and Wales with reform and enhanced investment have seen improvement in outcome comparable to non-NHS systems to northern countries in Europe, yet treatment and therapy rates are low by international averages.

Using data for 20 OECD from 1960 – 1992 countries in a multivariate regression equation and analysis, Berger and Messer (2002) found that the healthcare finance and system variable demonstrated substantial significance to health outcome (mortality rates), when introduced solely or under interacted into the regression. It was noted that higher mortality rates were positively associated with public finance system as were arrangements that produces less efficient services or productive packages, even after adding insurance coverage and health expenditure variables.

Particularly to disease management, Evans and Pritchard (2000) conducted a cross-national comparative assessment of GDP health expenditure on cancer survivals across 10 countries to include the US. It drew data from the US's Bureau of Statistics for wealth and GDP information, and the WHO Euro Care Study and US studies for cancer statistics. Using a Spearman rank correlation, the researchers found significant correlations between GDP health expenditures and cancer survival rates, and noted the UK ranked lowest at 6.04% in health spend while 11.03% in the US. Results demonstrated best cancer outcomes among the higher spending countries, and distinct poorer cancer outcomes among NHSs; their GDP health spending falling around 6% and reported outcomes of shortest survival rates for both male and female cancers. Overall, the evidence is biased to cost-inefficiencies of the public system. Comparable improvement and performance data is limited.

3. RESEARCH METHODS

3.1. Data Sources

The rising concern over increased incidence provided an exploratory framework on the economics of diabetes management. North American and Caribbean (NAC) region is selected because of its high prevalence, while South and Central America (SACA) is also included for reasons of similar development challenges to the Caribbean.

North America and Canada are excluded from the set because they comprise developed nations. Main data sources are the International Diabetic Federation Atlas (2009) and WHO (2010). They provide data on the diabetes health spend prevalence, mortality and incidence rates.

Other data such as Health Expenditure per capita and GDP per capita are drawn the World Bank (2010) estimates. These combined sources are particularly important to examine the association between health expenditure for diabetes and related health indicators.

In sum, data were collected from international sources on 33 Latin American and Caribbean countries. 15 countries represent NAC region, while 18 are SACA countries.

Table 1 summarizes the selected countries.

Table 1. Selected 33 countries

Regions	Countries (NAC)
North American and Caribbean	Antigua, Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Mexico, Sait kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname & Trinidad and Tobago
South and Central America (SACA)	Brazil, Chile, Columbia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru, Uruguay & Venezuela

We do note that the secondary data are somewhat aggregated or extrapolated based on macro level constructions. Brown and Semradek (1992, p. 167) explain that such data may suffer significantly from issues of specificity and sensitivity among others, as they are being not accurately representative. However, the sources used for this study are of international repute and provide a framework for cross-referencing and comparisons.

3.2. Regression Model

We estimate the following model:

$$Diabetes\ Health\ Performance_i = \alpha + \beta Health\ Expenditure_i$$

i represents country selected for the study. Table 2 summarizes the diabetes health performance indicators (dependent variable) and the associated health expenditure measures

(independent variables). Independent monetary variables are transformed into logarithms to deal with the skewed nature of large monetary values in relation to other values.

Table 2. Diabetes health performance indicators and health expenditure variables

Diabetes Health Performance Indicators (DV)	**Health Expenditure (IV)**
Diabetes Health Performance Indicators - measured as: **Overweight BMI ≥ 25 kg/m²** **Obesity BMI ≥ 30 kg/m²**	Mean diabetes-related expenditure per person with diabetes (in US$) (MDEX) Per capita health expenditure (in US$) (PCHEX) Gross domestic product (GDP) per capita (in US$) (PCGDP)

We use Body Mass Index (BMI) as an outcome indicator for the diabetes health performance. Although Nicolucci, Greenfield and Mattke (2006) have suggested nine diabetes-related indicators for assessing the quality of health systems (for examples, HbA1c testing, LDL cholesterol testing, screening for nephropathy, HbA1c control, extremity of amputation rates, kidney disease and cardiovascular mortality in persons with diabetes), these measures are rather administratively sophisticated, more suitable for clinical-prescriptive type of study and only available within advanced OECD countries. In contrast, our study takes the issue of diabetes from the managerial perspective within the context of developing and underdeveloped countries. Clearly, data limitation is an issue here hence those indicators, as suggested by Nicolucci, Greenfield and Mattke (2006), are far from possible to be implemented in the present study. Ideally, WHO (2010) has listed BMI as an NCD indicator and also presented comprehensive and comparative estimates and risk data for all countries covered in this study.[1]

4. FINDINGS

4.1. Health Spending and Outcome

4.1.1. Descriptive Statistics

Table 3 presents the diabetes statistics for developing North American and Caribbean countries in 2010. Table 4 presents summary statistics of economic variables.

[1] We are grateful to the reviewer for highlighting this issue.

Table 3. Diabetes statistics for developing North America and Caribbean countries in 2010

Country/Territory	Adult Population (20-79) in 1000s	Diabetes National Prevalence (%)	2010 Diabetes Cases (20-79) in 1000s	Diabetes Related Deaths (20-79)	Death Rate for Diabetes	Mean Diabetes-related Expenditure per Person with Diabetes (US$)	Health Expenditure per Capita	GDP per Capita US$	Overweight 2010 BMI ≥ 25 kg/m²	Obesity 2010 BMI ≥ 30 kg/m²
Antigua and Barbuda	43.60	7.10	3.10	45.00	0.103	769	771	13,006	57.70	8.90
Bahamas	221.90	10.20	22.50	239.00	0.107	1,743	1,704	22,665	62.30	22.70
Barbados	218.70	9.20	20.10	228.00	0.104	908	1,003	15,035	74.20	39.60
Belize	163.70	7.90	12.90	160.00	0.097	320	262	4,057	52.30	15.00
Dominica	45.00	11.50	5.20	41.00	0.091	384	410	6,964	75.70	39.10
Grenada	59.70	8.50	5.10	91.00	0.152	592	438	7,500	55.60	17.30
Guyana	438.80	10.20	44.60	1,131.00	0.258	88	169	2,994	50.10	13.60
Haiti	5,303.10	5.90	313.00	7,326.00	0.138	48	46	664	38.30	11.20
Jamaica	1,600.60	10.20	163.60	1,284.00	0.080	238	259	4,966	62.90	28.00
Mexico	67,317.00	10.10	6,826.80	54,892.00	0.082	708	603	9,128	73.30	35.50
Saint Kitts and Nevis	24.80	9.00	2.20	31.00	0.125	659	598	12,847	58.30	19.30
Saint Lucia	107.30	8.60	9.30	80.00	0.075	488	528	6,947	63.30	25.80
Saint Vincent and the Grenadines	75.70	7.30	5.50	78.00	0.103	322	293	6,172	53.10	15.60
Suriname	289.30	10.30	29.70	363.00	0.125	303	472	8,324	50.40	13.80
Trinidad and Tobago	942.80	11.40	107.70	996.00	0.106	668	77	15,614	73.00	35.90

Table 4. Descriptive statistics of economic variables (in US$)

Independent Variables (US$)	N	Mean	Median	Minimum	Maximum	Std. Deviation
Mean Diabetes-related Expenditure per Person with Diabetes (MDEX)	33	437.39	376	48	1,743	319.32
Per Capita Health Expenditure (PCHEX)	33	524.21	438	46	1,704	359.20
Gross Domestic Product (GDP) per Capita (PCGDP)	33	7,619.13	6,947	664	22,665	4,947.09

Mean Per Capita Health Expenditure was noted at US$524.21 with minimum and maximum values of US$46 and US$1,704 and a median of US$438. The GDP per capita displays a mean of US$7,619.13 with minimum and maximum values at US$664 and US$22,665, respectively. The mean for Mean Diabetes Related Expenditure falls at US$437.39 with a minimum of US$48 and maximum of US$1,743. Overall, these statistics indicate that the overall health expenditures in NAC and SACA countries are relatively lower than those developed countries. Comparatively, while SACA countries demonstrated lower mean expenditures, minimum expenditure counts were twice that of minimum values for NAC, as Table 5 displays. Mean GDP Per Capita demonstrated the widest difference – NAC countries are having 43.39% higher mean than SACA. NAC also showed widest differences between minimum and maximum expenditures. Standard deviations are close to the means for both diabetes-related and per capita expenditure, but are further away from the data point in the case of GDP per capita. NAC region records a wider deviation for this variable.

4.1.2. Correlation Analysis: Wealth, Diabetes Health Spending and Outcome

In assessing the association between wealth, spending for diabetes and NCD health indicators, the correlation coefficients for Diabetes Health Performance Indicators are plotted against the logarithms of health expenditures (MDEX, PCHEX and PCGDP).

Table 6 presents the results. It clearly shows that the MDEX, PCHEX and PCGDP are not only positively correlated, but also statistically significant, with both Diabetes Health Performance Indicators (i.e., Overweight Prevalence and Obesity Prevalence). Thus, we reject the null hypothesis that there is no association between wealth, GDP data, general and diabetes health spending and outcome-overweight indicators, and accepts the alternative that there is an association among all these.

4.2. Regression Results

Tables 7 and 8 present the regression results of Diabetes Health Performance Indicators on Heath Expenditure variables. From Table 7, the estimated equation is:

$$\widehat{OWBMI} = 23.692 + 6.374MDEX$$

where $OWBMI$ is the overweight 2010 BMI and $MDEX$ is the log of the mean diabetes-related expenditure. The "^" over $OWBMI$ in the above equation indicates that it is the predicted value based on the Ordinary Least Squares (OLS) regression line.

Table 5. Regional expenditures (in US$)

Expenditure (US$)	South and Central America (SACA)						North American and Caribbean (NAC)					
	N	Min	Max	Mean	Median	Std Dev.	N	Min	Max	Mean	Median	Std Dev.
Mean Diabetes-related Expenditure per Person with Diabetes (MDEX)	18	120	671	344.22	310.50	172.70	15	48	1,743	549.20	488	415.07
Per Capita Health Expenditure (PCHEX)	18	108	990	487	362.50	310.07	15	46	1,704	568.87	472	417.42
Gross Domestic Product (GDP) per Capita (PCGDP)	18	1,456	13,658	6,363.80	5,493.70	3,894.91	15	664	22,665	9,125.53	7,500	5,749.98

Table 6. Correlation coefficient between diabetes health indicator and health expenditure variables

Diabetes Health Performance Indicator	MDEX	PCHEX	PCGDP
Overweight BMI ≥ 25 kg/m²	.501 ***	.485 ***	.515 ***

Note: MDEX= Mean Diabetes-related Expenditure; PCHEX = Per Capita Health Expenditure; PCGDP = Per Capita Gross Domestic Product. *** $p < 0.01$ and ** $p < 0.05$ levels.

Table 7. Regression equation coefficients (diabetes spending and outcome)

		Unstandardized Coefficient		Standardized Coefficient	t	Sig.	95.0% C.I.for (B)	
Model		B	Std. Error	Beta			Lower	Upper
1	(Constant)	23.692	11.645		2.035	.051	-.057	47.442
	MDEX	6.374	1.978	.501	3.223	.003	2.340	10.407
$R^2 = 0.251$								

Note: Dependent variable: OVERWEIGHT 2010 BMI >/= 25kg/m^2.

Table 8. Regression equation coefficients (wealth and outcome)

		Unstandardized Coefficient		Standardized Coefficient	t	Sig.	95.0% C.I.for (B)	
Model		B	Std. Error	Beta			Lower	Upper
2	(Constant)	6.413	16.364		.392	.698	-26.961	39.788
	PCGDP	6.268	1.874	.515	3.345	.002	2.446	10.090
$R^2 = 0.265$								

Note: Dependent variable: OVERWEIGHT 2010 BMI >/= 25kg/m.

The slope of 6.374 means that a 1 unit increase in log mean diabetes-related expenditure, on average, is associated with a 6.374 increase in Overweight Prevalence. That is to say, a change in MDEX from 4 (i.e., mean expenditure of US$54.60) to a MDEX 5 (i.e., mean expenditure of US$148.41) will result in a 6.374 increase in Overweight Prevalence.

The output from Table 8 reveals the following estimate:

$$\widehat{OWBMI} = 6.413 + 6.268PCGDP$$

where by the slope of 6.268 means that a 1 unit increase in log per capita GDP, on average, is associated with an increase of approximately 6.268 in Overweight Prevalence. Here, 26.5 % of variance of dependent variable $OWBMI$ can be explained by the regressor - PCGDP, given the R^2 of 0.265.

Figures 1, 2 and 3 superimpose the regression line on the scatter plot of the log of mean diabetes expenditure, log of per capita GDP and overweight prevalence respectively. The figures also demonstrate that the estimates are reasonable, since all countries in the sample fall within the 95% confidence interval.

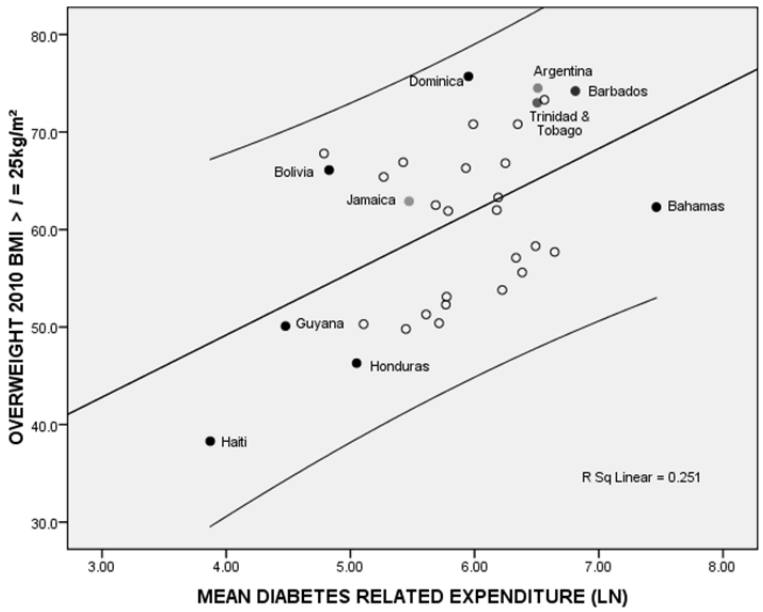

Figure 1. MDEX and overweight prevalence displaying regression line and 95% CI parameters.

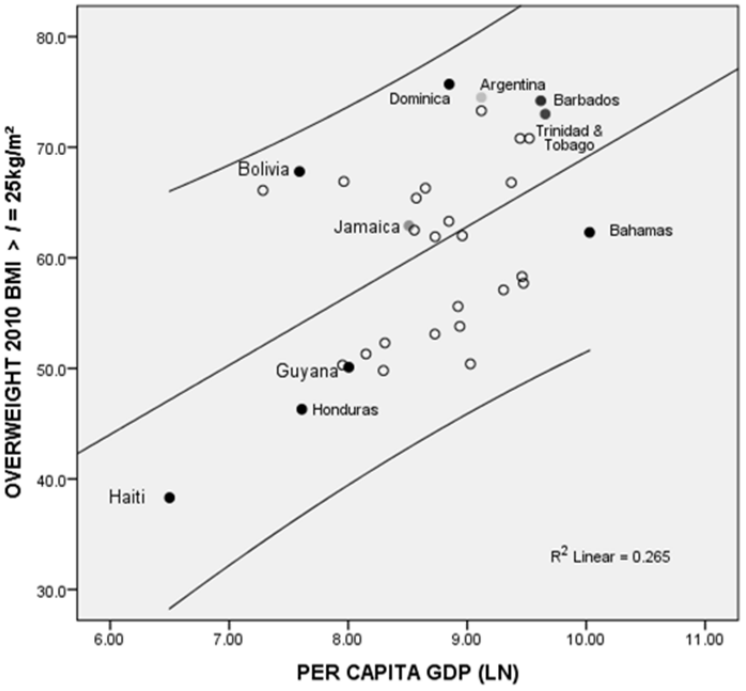

Figure 2. PCGDP and overweight prevalence displaying regression line and 95% CI parameters.

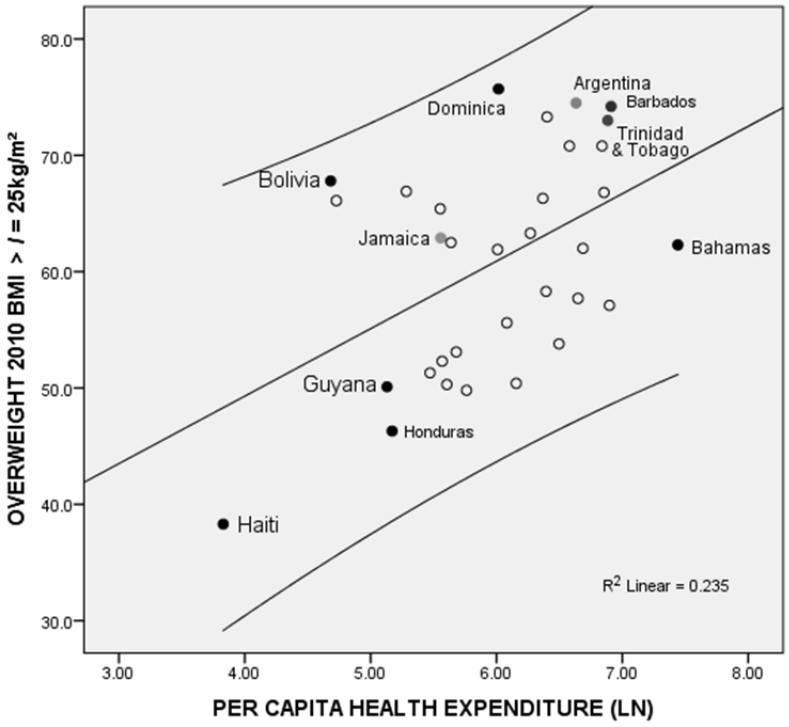

Figure 3. PCHEX and overweight prevalence displaying regression line and 95% CI parameters.

5. DISCUSSION

The theoretical and empirical literature, as reviewed in Section 2, suggests a linear relationship between wealth, diabetes expenditure and diabetes outcome; in which higher levels of capital and spending are accruing to better outcomes. Surprisingly, the reverse is seen in this present study. What the regression models above predict does not nullify previous theory, but rather emphasizing a conditionality of disease management. Of concern is the nature in which sustained prevalence within underdeveloped economic positions, in tandem with complexity of cultural, biological and sociological variables affects wealth, spending and investment, as well as performance.

Trinidad and Tobago, Argentina, along with Barbados are ranked high as per expenditure and wealth, and conversely, are amidst the top 5 in overweight prevalence. Contrastingly, Haiti records the lowest MDEX, PCHEX and PCGDP expenditure and overweight prevalence, and can be considered to have one of the most cost-efficient systems as far as chronic care is concerned. However, it is not assumed that this is a causal relationship, as other factors may be in play, such as poverty and malnutrition. Honduras, however presents a more realistic picture of cost-efficient system.

While a higher diabetes expenditure and wealth assume advanced treatment and better medication, there seems to be a disconnection between the larger population and an apparent overwhelming focus on clinical care as opposed to prevention. While this may not be a direct

cause of system underperformance, in an economic sense, aside from other, social and cultural variables, high overweight prevalence suggests substantial potentially undiagnosed cases, and more so, the suboptimal use of wealth and investment. Therefore, an increased economic burden is presumed. In this respect, technical efficiency of governments on disease resources appears to have assumed a narrow focus, and these systems can be considered to have suboptimal or x-inefficient performance. This is in keeping with Leibenstein's (1978) assumptions that x-inefficiency operates where excessive input over that of the minimum results in minimum returns, as was dominant in 87% of public hospitals in South Africa who operated inefficiently and sub-optimally, their resource use exceeding optimization levels by 35.1 - 46.8 per cent (Zere, McIntyre and Addison, 2001).

SUMMARY AND CONCLUSION

This research was set out to appraise the influence of wealth and health spending on performance and outcome for diabetes management. We wished to explore how spending in the regional and national arena for diabetes is associated with outcome indicators, and more so, whether the investment-outcome relationship was indicative of traditional expectations.

Strong positive correlations were found between specific diabetes related expenditure and GDP data and population-based NCD indicators; overweight prevalence. Of significance, spending and outcome within the North American and Caribbean Region and the South and Central American region suggested a departure from the health production function, where increased spending should improve outcome. The results demonstrated that an increase in log Mean Diabetes-Related Expenditure by one unit suggested an increase in overweight prevalence by 6.374. Similarly for the variable of wealth, the output also showed a change in overweight prevalence by 6.268 with a one-unit increase in PCGDP. Strangely, the majority of countries with smaller investments and less capital demonstrated better or parallel outcome in some cases. Such is linked to the postulation of Theodore (2011) that economic growth in the region allowed for a paradox, where wealth equated to a divergence from health practices towards sedentary lifestyles and poorer nutrition with the influx of urbanization.

Theodore (2011) made a critical contribution on the impact of the economy on the incidence of CNCD, paying attention on Trinidad and Tobago. In it, the increased standard of living of the citizen saw a decrease in the consumption of fruits and vegetables to the increased consumption of 'fast-food'. It alludes to the fact that improved standard of living, cost of living and economic demands are at odds, causing elastic pressures for healthy living.

With the economy as the driver of NCDs, greater attention at the policy level is to be placed on nationalizing dietary practices, through health education, social marketing and the reengineering of the agricultural sector to reduce inflationary pressures and increase the dependence on locally grown agricultural items. It further means a mobilization and integration of the medical fraternity and other teams in the direction of preventative mechanism geared at community reeducation, farming as well as targeted community sporting and activity programs beyond the ambit of competition.

Overall, with the alarming overweight prevalence nationally, there needs to be a reprioritization and refocus to downstream preventative, population health, backed by policy and regulatory support, a solid institution and an adept health management core. Thus, it would be beneficial if the Governments lead the effort in stimulating reform, by firstly

redefining its role in health as an investor that demands return, driving competition and performance within its health system.

The study presents two limitations. First, we recognise the inability of the data to differentiate and disaggregate between clinical and preventative costs and investments towards streamlining a closer approximation related population health, and further account statistically for contingent factors that influence overweight prevalence. However, population level input, per capita health expenditure does not depart significantly from regression results of diabetes related outcome, showing a sticking resemblance in investment response. Second, the study looks at one particular year rather than a period. A comprehensive examination of a protracted period, relationship and response between the indicator and the investment may more accurately map socio-economic trends and present a better picture of growth of investment and changes in outcome. Herein lies the prospect for future research.

As the preceding paragraph indicates, accounting for other factors that influence overweight prevalence is a starting point into deriving more robust estimations of the relationship, paying particular attention to patient-level and socio economic features; and further to comparatively assess health system types, institutional and political configuration within the region are features still to be explored. It would be instructive if a comprehensive research were conducted on model islands with similar typology both at the cost-effective and x-efficient ends of the spectrum. Such can unearth best practices to allow for system improvement regionally and ultimately the retention of regional wealth, as well as allowing for the reforming of technically flawed systems, by way of reform and audit.

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