Health and Distance to Health Care in Papua New Guinea

Alice Louise Kassens, Roanoke College

Yana van der Meulen Rodgers, Rutgers University

Prepared for the volume *Disease, Human Health, and Regional Economic Growth and Development in Asia*, edited by Peter Nijkamp, Yoshiro Higano, and Amitrajeet Batabyal

Abstract: This study uses household survey data from 2009-2010 merged together with geospatial data from the United Nations on health facilities to examine the association between distance to health care facilities, health, and health care usage in Papua New Guinea, one of the most isolated and rural countries in the world. Greater distance from health care facilities reduces access to health care by presenting transportation challenges and is expected to reduce both health care usage and individual health. Results from multivariate regression analysis suggest distance is a detracting factor, although other factors such as education, socioeconomic status, and access to resources matter more.

Notes: Corresponding author is Alice Louise Kassens, Business and Economics Department, 221 College Lane, Roanoke College, Salem, VA 24153, email kassens@roanoke.edu. We thank Sunhwa Lee for her helpful comments on an earlier version of this study and Katie Edwards for her valuable research assistance.

I. Introduction

Many individuals in developing countries go without the health care that could increase their life expectancy and quality of life. In these countries, the greatest rates of underutilization are amongst those in the bottom income quintiles (O'Donnell, 2007). Many of the communicable diseases pervasive in Papua New Guinea, including malaria, have effective treatments available. Availability and access to health care is impacted by the supply and quality of health care workers and medical provisions, quality of roads, number of health care facilities and beds in those facilities, transportation, distance, and income. There is significant variation in access and availability across Papua New Guinea. For some residents, access to a health care facility requires a several hour trip by boat or foot.

One of the causes of the underutilization of health care by the poor in developing countries is the distance to facilities with needed health care goods and services (O'Donnell 2007). Global positioning systems (GPS) and mapping software can be used to adequately assess the distance to health care facilities by community (Baker, Bazemore, & Jacobson Jr., 2008). When paired with health care facility usage data, policymakers can estimate the effect of distance on access to and demand for health care in rural areas, crucial information to the development of effective policy. Distance to facility with adequate resources would be less of an issue, however, if roads were improved.

This analysis utilizes data from Papua New Guinea's 2009-2010 Household Income and Expenditure Survey (HIES), a rich household-level dataset that has detailed information on human capital indicators, socioeconomic status, health, and individual-specific information on health facility usage, health outcomes, and access to transportation. These data are merged with

geographical data on health facilities to determine how distance from health facilities and the quality of transportation services and infrastructure affect health facility usage. We are also interested in how access to and usage of health facilities differ by gender and by urban/rural status. Our analysis is based on a GIS modeling approach as well as ordinary least squares regressions that control for a complete set of individual and household characteristics.

II. Country Background

Papua New Guinea is one of the world's most rural countries. The majority (86 percent) of Papua New Guinea's households still live in the rural sector, with more than one third of the population residing in the Highlands region and more than a quarter residing in the Momase region (Figure 1).[1] Moreover, Papua New Guinea's rural sector has a relatively high dependency ratio compared to other Asian countries. Like other tropical and subtropical countries, communicable diseases, particularly malaria and tuberculosis, are the major cause of morbidity and mortality in Papua New Guinea. The highest incidence of malaria is reported in the Southern, Island, and Momase regions and the lowest incidence is reported in the Highlands. The low incidence in the Highlands is likely due to the altitude; the malaria parasite and its mosquito carrier do not thrive at high altitudes and lower temperatures. Warmer temperatures and lower altitude likely contribute to the higher incidence in the Southern, Island, and Momase regions. Among children in Papua New Guinea, mortality rates for children under the age of five have been declining, largely due to reductions in death from malaria and pneumonia. Malnutrition is thought to be the leading cause of death amongst children and has been perhaps overlooked in the fight to control other causes of death (Aipit, Aipit, & Laman, 2014).

[1] These percentages are tabulated by the authors using the full sample of 22,718 individuals in the 2009-10 HIES.

Not only is Papua New Guinea one of the most rural countries in the world, it also has one of the most isolated populations, with four out of five people living in rugged or coastal terrain without access to roads and public transportation (World Bank, 2013). Poor infrastructure potentially deters the use of health care facilities, and the primary mode of transportation to medical facilities in all but metropolitan areas is walking. Coupled with higher income and accessible roads, vehicular transportation is a more common mode of transportation to health care facilities in metro areas. Restricted or poor access to roads and public services in rural areas has been documented as a major obstacle to accessing to health care in Papua New Guinea's rural areas, especially for women and children (Bauze, et al., 2012). Women are more likely to walk to receive health services, suggesting that those women too sick to walk or are unable to carry a sick child may not be seeking needed care. The costs of other modes of transportation have increased 40 to 60 percent in rural areas since the early 2000s, thus exacerbating healthcare access issues (World Bank, 2013).

Table 1 illustrates mode of transportation to health care facility by gender and urban status for HIES respondents' most recent visit to a facility. Note that the data include all individuals ages 15 and over. The primary mode of transportation to health care facilities in rural areas is walking. Almost three quarters of people residing in rural areas walk to a health care facility, with no discrepancy by gender. Coupled with higher income and accessible roads, vehicular transportation, both public and private, are more common modes of transportation to health care facilities in urban areas. Again, the gender differences are quite small, with a slightly higher percentage of men than women using private vehicles, while a slightly higher percentage of women than men use public buses.

Table 2 shows the type of health care facility that is used in urban and rural areas by men and women who sought treatment for a health problem in the past thirty days and attended at least one facility. Public hospitals and clinics are the most frequently used type of health care facility, particularly in urban areas. About half of all men and women sought treatment for a health problem in a public hospital or clinic, with very little difference between men and women. Another 11 percent of men and women sought treatment in a private hospital in urban areas. In contrast, church run facilities and other public facilities, including government health centers and aid posts, are more commonly used in rural areas. Facility use is driven by facility location, thus explaining the greater use of health centers and aid posts in rural areas of Papua New Guinea. Substantial gender differentials are not apparent.

Table 3 illustrates health care facility use by expenditure quintile and urban status for those who sought treatment for a health problem in the past thirty days. When the facility use responses are cut across expenditure quintile the sample sizes get quite small; caution should be used when evaluating the distribution, particularly for those infrequently used health care facilities. In rural areas, all groups use public facilities, although the poor are more likely to use a government aid post, while the relatively wealthy are more likely to use public hospitals and health centers. Church health centers are also utilized in rural areas across the expenditure quintiles, though more frequently by the upper tail of the expenditure distribution. Church facilities are highly subsidized by the government. When coupled with government health centers and sub-centers, they provide a variety of services for rural areas and serve as intermediary points of care for higher-level facilities and hospitals (World Health Organization, 2013). Church groups commonly run smaller sub-centers for health care in rural areas, which offer the same services as their larger counterparts. The urban poor almost exclusively use public

facilities, particularly hospitals and health centers. Comparatively, their wealthier peers most intensely use public hospitals and health centers, but also visit a wide range of church and private facilities.

Table 4 shows the types of illnesses for which respondents seek treatment at health facilities by urban status. Malaria and coughs are the most common ailment in urban and rural areas, although visits for coughs are more common in rural areas and visits for malaria in urban areas. Several other ailments that could be related to malaria and coughs are also common reasons to seek treatment, especially fever and headache. A sick person may not to go to a health facility for many reasons including distance, cost, and quality of care. Some illnesses may weaken a person such that traveling to a health facility is not feasible, particularly if walking is the only mode of transportation. Table 5 shows the reported reasons for not going to a health facility for individuals who were sick in the last thirty days. In urban areas, 90 percent of respondents did not go to a health facility because either their illness was not serious enough or they treated it at home, compared to 60 percent in rural areas. Distance to a health facility is only an issue for those in rural areas. About 19 percent of respondents in rural areas state that they did not get treatment at a health facility because the distance was too great.

III. Conceptual Framework and Previous Evidence

This study's estimation model is based on a health production model originally developed in Grossman (1972a, 1972b) which explains how various inputs impact the production of health through the demand for health capital. Health is considered a durable capital good from which individuals gain utility not from the health itself, but from the use of time for which they are healthy. Individuals want good health, but cannot purchase it directly in the marketplace.

Instead, health is produced by combining time and medical inputs. Health is both a consumption and investment good. Consumption of health makes people feel better and is utility generating. As an investment good, health increases the number of days available to work and earn income. It is assumed that an individual is endowed with an initial stock of health at birth that depreciates over time until death. Individuals can modify the rate of depreciation of their health through various activities. Some activities, like exercise, slow the rate of depreciation while others, like smoking, increase it. Individuals can increase their time spent in the labor market and their productivity by increasing their stock of health, which makes health investments a form of human capital investment.

In the basic Grossman model, an individual's intertemporal utility function depends on their health endowment, their stock of health across time, and their consumption of other commodities as follows:

$$U = U(\alpha_0 H_0, \alpha_1 H_1, \ldots, \alpha_n H_n, Z_0, \ldots, Z_n).$$

The notation H_0 denotes an individual's initial stock of health with which they are endowed at time 0, H_t is the person's endogenous stock of health at time t, α_t represents the service flow per unit of health stock that an individual enjoys in period t, and Z_t represents the aggregate consumption of all non-health goods in period t, and n represents the period for which the individual plans in the future. Total length of life is assumed to be endogenous and death takes place when a person's health stock falls below a minimum threshold H_{min}.

In the model, the net amount of investment in an individual's health stock over time depends both on that person's gross investment in and the depreciation of their health stock. The rate of health depreciation is assumed exogenous and varies with age. An individual's gross

investment (I_t) and aggregate consumption (Z_t) are defined according to two household production functions:

$$I_t = I_t(M_t, TH_t;\ K)$$

$$Z_t = Z_t(X_t, T_t;\ K)$$

I_t denotes an individual's gross investment in health; M_t represents a vector of commodities purchased in the marketplace that contribute to gross investment in health, including medical care; TH_t and T_t signify the time that individuals invest in their health and in the aggregate consumption good Z_t, respectively; K represents an individual's exogenously determined stock of knowledge that helps to improve the efficiency of household production; and X_t denotes the individual commodities purchased in the marketplace used in the household production of the aggregate consumption good Z_t. Both production functions are linear and homogeneous in their respective marketplace good (M_t and X_t) and time inputs (TH_t and T_t). The marketplace goods and time inputs are each assumed endogenous, in limited supply, and subject to constraints. The time budget constraint allows for time lost from market and household activities due to illness and injury which is inversely related to the stock of health.

Individuals are assumed to choose the utility maximizing level of health stock H_t and aggregate consumption Z_t in each period, subject to the net amount invested over time in health (including depreciation), and their production, resource, and total budget constraints. In equilibrium, the optimal quantity of investment in each period determines the ideal quantity of health capital (Grossman 1972a, 1972b). One implication of this model is that, since travel time to health facilities is part of the cost of medical care, distance and travel time to health facilities reduces the demand for medical care. Medical care is rationed by its market price and indirect

costs such as access, including travel time and distance. Hence, travel to a medical facility enters the health production function.

A growing number of empirical studies use geospatial measures of health care access combined with multivariable regression analysis to examine how distance to health facilities affects health outcomes and medical care usage. Travel to a health care facility is a spatial dimension of health care access that can be measured in terms of distance or time. Geographical access to health care, in turn, refers to the spatial relationship between someone who demands health care and someone who supplies it; this concept differs from the availability of health care which refers to whether there is an adequate supply of health care providers relative to demand (Nesbitt, et al., 2014). The spatial dimension of health care access also contrasts with other features of health care access, including affordability, social acceptability, red tape, perceptions of poor quality, and poor information about services (Rosero-Bixby, 2004). Studies indicate that households in rural areas of developing countries tend to use the nearest health facility in terms of geographical distance (see, for example, Tanser *et al.* 2001). Moreover, straight line distance between the household and the health facility is often correlated with road distance and travel time, a finding that is helpful in modeling health care access when data on roads and travel time are not readily available or reliable (Al-Taiar, Clark, Longenecker, & Whitty, 2010).

Most findings point to an inverse relationship between distance to a health care facility and health outcomes, where health outcomes are often measured by utilization of a facility. For example, a strong association between distance and health care access is found in Niger, where 90 percent of roads are unpaved (Blanford, Kumar, Luo, & MacEachren, 2012). In this case, children who live within an hour's walk from the nearest health center have almost twice the odds of getting their complete vaccinations by the age of one compared to children living farther

away. An inverse relationship between distance to the nearest health facility and children's vaccination rates is also found in Yemen (Al-Taiar, Clark, Longenecker, & Whitty, 2010). Early neonatal mortality is also associated with distance to health facilities. In Ethiopia, early neonatal deaths increase by 14.4 deaths per 1,000 live births among those living more than 80 kilometers from a comprehensive emergency obstetric and newborn care facility compared to those living within 10 kilometers of such a facility (McKinnon, Harper, Kaufman, & Abdullah, 2014). Efforts by the Ethiopian government to improve access to obstetric and newborn care facilities will potentially reduce early neonatal mortality rates.

Spatial disparities are often confounded by racial differences in access to health care. For instance, in South Africa, there are marked differentials by race and income in distance from the nearest public clinic, with 14 percent of black South Africans living more than 5 km from the closest clinic as compared to just 4 percent of whites (McLaren, Ardington, & Leibbrandt, 2014). Accordingly, black adults are less likely than white adults to have a health consultation in the past year. Similarly, black children below the age of five are less likely to have a skilled attendant present at their birth compared to their white counterparts. In Ghana, women's odds of giving birth in the presence of a skilled health professional are also inversely related to distance to the nearest health facility (Nesbitt, et al., 2014).

IV. Data and Methodology

Several datasets contribute to the sample used to estimate the determinants of health facility usage and health in Papua New Guinea. We use Papua New Guinea's 2009-2010 Household Income and Expenditure Survey (HIES) for spatial and non-spatial data pertaining to households. Latitude and longitude measures are provided by HIES supervisors and noted by

interviewers for each household prior the interview, although not all information is complete. Additionally, some latitude and longitude values are switched and need adjustment prior analysis while others are outside of the possible coordinates for Papua New Guinea (0 to -12 degrees latitude, 140 to 154 degrees longitude) and are set to missing. The final analytic sample of adults aged 15 and over who have geospatial data pertaining to the nearest health provider includes 13,193 individuals and 3,904 households.

Spatial data for health care facilities are provided by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). Collected in 2000, the data set includes 705 locations ranging from district hospitals to aid posts. It is a uniquely available dataset that contains spatial coordinates for many health facilities, permitting the estimation of the nearest neighboring health facility for each household. Because the HIES data contain spatial coordinates for all respondent's household location, we merged these two datasets and have information for each household and their nearest health facility.

Unfortunately, the HIES only provides data on distance to the nearest health facility for households with a member who visited a health provider in the past 30 days or 12 months, depending on survey question. Thus, if a respondent visited no providers, then we have no information within the HIES about distance to a health facility for that respondent, and we must obtain this information from an outside source. The self-reported distance data from the HIES cannot be used for our regression analysis as the survey questions on distance are only answered for household members who visited a health facility. An additional issue with the distance measures in the HIES dataset is that they are self-reported by the head of household, subjecting the measure to reporting error. The main drawbacks for the OCHA data set are 1) it was collected several years before the HIES was conducted and therefore some facilities may have

opened or closed in the intervening period and 2) it represents only a portion of the actual number of health facilities reported in some government documents.[2] Despite these disadvantages, we rely on the OCHA spatial data for health facilities to overcome the larger constraints imposed by the HIES distance and travel time information.

Figure 2 shows each household and health care facility in Papua New Guinea layered with the national road network, also from OCHA. Households and health facilities are clustered together and fall along roads. Given the nature of the supply and demand for infrastructure (roads) and services (health facilities), the clustering and tracking with households is not surprising and reflects the precision of the GPS data in both the HIES and OCHA data sets.

Two distance measures are generated using Stata functions. First, *geonear* (Picard, 2012), which estimates the geodetic distance between each household and health care facility (the length of the shortest curve between two points on a sphere), generates a variable measuring the distance of the nearest neighboring health facility for each household measured in kilometers. This variable minimizes the Euclidean distance, $d_E(i,j) = \left[\sum\left(x_{ik}, x_{jk}\right)^2\right]^{1/2}$, between household i, with coordinates (x_{i1}, x_{i2}), and the j health facilities, with coordinates $\left(x_{j1}, x_{j2}\right)$, available to it. Given Euclidean distance is often not the route taken by individuals from one location to another, we also employed the *georoute* (Weber & Peclat, 2016) function which estimates the distance between two points using available road network data through the HERE API. The function generates the distance most likely travelled in kilometers for each household and nearest

[2] We conducted an extensive search for spatial data encompassing most if not all of the reported health facilities in Papua New Guinea, but were unsuccessful. Additionally, outreach to the national statistics office in Papua New Guinea for spatial coordinates of the health facilities reported in (National Department of Health, 2011) was unsuccessful. The OCHA data set is the best data currently available.

neighboring health facility pair. *Georoute* also estimates the travel time in minutes between two locations. In total, the GIS data yield two distance and one travel time measures.

Table 6 presents sample means for all the dependent and independent variables, including the travel distance and time measures, at the individual level. Most striking is the differential in average educational attainment between urban and rural areas. In urban areas, 65 percent of individuals have secondary or tertiary education compared to 26 percent of individuals in rural areas. The opposite is true of people with less than primary schooling, where the percentage of people with very little to no education in rural areas is about triple that of urban areas. Households are larger in urban areas by an average of 1.5 persons per household. Although families in urban areas are less likely to claim ownership of their dwellings than their rural counterparts, they are far more likely to have access to tap water and improved toilets. About half of the urban sample is concentrated in the Southern region of the country (home to the nation's capital city Port Moresby), while rural individuals are more evenly distributed across regions. Also of note, one third of the sample in rural areas reported having a health complaint in the past thirty days compared to 24 percent in urban areas. However, the average likelihood of visiting a facility in the past month (51 to 52 percent) or being hospitalized in the past year (4 to 5 percent) is about the same across urban and rural areas. As expected, the Euclidean travel distance to the closest health facility is greater in rural areas (23 km) than in urban areas (16 km). It also takes individuals more time to reach health facilities in rural areas (27 minutes) than urban areas (24 minutes). That said, 16km between the average individual and the closest health facility in an urban area is still surprisingly far given the population densities of urban areas. Interestingly, the average Euclidean distance is quite close to the distance by roads in both urban

and rural areas. Data sources and construction for the key dependent and independent variables are described in more detail in Table 7.

The empirical analysis continues with a logistic regression analysis of the determinants of health status and health facility usage. The estimation equation is specified as follows:

$$Y_i = \beta_0 + \beta_1 A_i + \beta_2 X_i + \varepsilon_i$$

The notation Y_i denotes one of three variables: 1) if individual *i* experienced a health complaint in the last 30 days; 2) if individual *i* used a health facility in the past 30 days for a health issue, or 3) if individual *i* was hospitalized in the past 12 months. The variable *A* is the distance to health facility in kilometeres or time travel to facility in minutes, and the matrix *X* represents individual and household-level controls including: gender, age, smoking status, illness (in the case of the two utilization dependent variables), household expenditure quintile, marital status, access to clean water, and an improved toilet. All statistical analyses are weighted to the national population using the sampling weights provided with the HIES. Because the survey records multiple individuals per household as separate observations, for analysis at the individual level we correct the standard errors for clustering at the level of the household.

V. Regression Results

The logistic regression results for reporting a health complaint in the past 30 days are reported as odds ratios in Table 8. The odds ratio reflects how the likelihood of an event changes as a particular variable changes. When the odds ratio equals 1, the likelihood of the event occurring does not change; when it is greater than one, the likelihood of the event happening increases; and when it is less than one, the likelihood of the event happening decreases. Odds ratios are always positive numbers. Table 8 shows that for the entire sample, a one kilometer

increase in the distance to the closest health facility increases the odds of reporting a health complaint by 0.4 percent. Similar results are found for those residing in rural areas. The largest distance effect is in the urban areas, where a one kilometer increase in the distance to the nearest health provider increases the odds of reporting a health complaint by 1.1 percent.

Several factors matter more to individuals' health status than distance and travel time. Men are considerably less likely than women to report a health complaint, ceteris paribus, and this result holds in both urban and rural areas. Not surprisingly, smoking raises the odds of reporting a health complaint, as does getting older. In keeping with health production theory, those with greater education and assets are healthier. The odds of individuals with tertiary degrees reporting a health complaint are about 25 percent lower than individuals with no schooling, and most of this effect is in rural areas. Individuals living in dwellings owned by the household are also less likely to have health complaints. Additionally, the odds of reporting a health complaint are lower for individuals living in households with more children and working-age adults in the household. This result suggests a joint production of health across individuals within the household. Living in urban areas reduces the odds of reporting a health issue by about half. More perplexing is the difference between urban and rural areas in the effect of having improved toilet facilities. Individuals in households with improved toilets are less likely to report a health concern in urban areas, while having an improved toilet facility in rural areas raises the odds of reporting a health issue by more than 50 percent.

Table 9 shows the odds ratios for visiting a health facility in the past 30 days conditional on reporting a recent health complaint. Based on that condition, the subsample is less healthy and smaller than the overall sample. Distance and time travelled appear to play little role in usage of a health facility for an illness. Although the odds ratios for distance and travel time by

road to the nearest health facility are statistically significant, the magnitudes are very close to 1.0, suggesting the odds of visiting a health facility are virtually the same with each additional kilometer or minute of travel. The odds of men using a health facility when ill are lower than women in rural areas but greater in urban areas. The poorest individuals, relative to the wealthiest, exhibit lower odds of visiting a health facility when ill in rural areas, but considerably greater odds in urban areas. One possible explanation is that the poorest households have greater access to financial resources to fund visits to health providers in urban areas relative to their rural peers. There are no other significant differences across expenditure quintiles. In urban areas, for each additional child in the household, the odds of visiting a health facility increases between 10 and 18 percent, indicating health maintenance is a greater priority in households where children are present. Health facility usage depends significantly on urban status and region of residence. Overall, urban residents are considerably less likely than rural residents to visit a health provider when sick or injured. Looking at the disaggregated results by urban and rural status, relative to individuals in the Southern region, individuals in Papua New Guinea's other regions (especially the Highlands) are generally more likely to visit health centers if they live in urban areas, but less likely to visit health centers if they live in rural areas. It is not clear why these regional results change by urban and rural status.

Table 10 reports the odds ratios for hospitalization in the past 12 months, which by survey design are not conditional on having a health complaint. However, it is likely that a hospital admission requires a higher level of illness than simply visiting a health facility. Increasing the distance to the nearest health facility including hospitals, measured by Euclidean distance, reduces the odds of a hospital admission in urban areas by 0.7 percent. When measured by road route, the odds are reduced by 0.8 percent to 1.0 percent overall and in rural areas,

respectively, but are greater by 1.0 percent in urban areas. Road routes through the *georoute* command are more accurate in urban areas and the increase in odds is likely capturing the greater access to public transportation.

Regardless of urban status, the odds of a male hospital admission are about 60 percent less than a female one. Individuals in the poorest quintile are 60 percent less likely to be admitted to a hospital relative to those in the top quintile, particularly in rural areas. Each adult in the household decreases the odds of a hospital admission in rural and urban areas, again suggesting more efficient household production of health in households with more adults. The marginal child increases the odds of an admission in urban areas. Relative to a male-headed household, the odds of a hospital admission for those residing in a female-headed household is between 40 and 85 percent greater. This result may stem from female decision-makers investing more in health care for everyone under their roof, including children. Access to clean drinking water dramatically reduces the odds of a hospital admission, while having an improved toilet has no effect.

VI. Conclusion

This study has examined the determinants of health status and health care utilization with an empirical model grounded in a theoretical health production model and estimated with nationally-representative household survey data. Our key question is whether distance from health providers can explain the underutilization of health facilities in Papua New Guinea as is often the case in other developing countries. Our results indicate that in most cases, individuals are less likely to seek health care with each additional kilometer or minute that they must travel. However, the magnitude of these effects are rather small, suggesting that investment in more

public health facilities may be less of a priority than other public investments as the government seeks to improve access to health care services (National Department of Health, 2011). The National Health Service Standards, approved by Papua New Guinea's government in 2011, were designed in part to ensure that the country's health services provide quality health care and are closely integrated with other government functions, including infrastructure planning and investment. We find that education, other indicators of socioeconomic status, and access to resources such as clean water and sanitation services matter more in health status and decisions to seek health care. These findings suggest that government efforts to invest in education, poverty reduction, and public infrastructure may do more to improve health care utilization than building new health care facilities.

In interesting question for future research is how these findings differ for young children and whether parents are more or less deterred by distance from health care facilities in seeking treatment for their children. Addressing this question requires both a different conceptual framework as well as a new estimation model since young children by and large depend on their parents for making their health care decisions, and a number of household dynamics can enter into these kinds of decisions.

References

Aipit, S., Aipit, J., & Laman, M. (2014). Malnutrition: A neglected but leading cause of child deaths in Papua New Guinea. *The Lancet. Global Health, 2*(10), e568.

Al-Taiar, A., Clark, A., Longenecker, J., & Whitty, C. (2010). Physical accessibility and utilization of health services in Yemen. *International Journal of Health Geographics, 9*(1), 38.

Arcury, T., Preisser, J., Gesler, W., & Powers, J. (2005). Access to transportation and health care utilization in a rural region. *Journal of Rural Health, 21*(1), 31-38.

Baker, J., Bazemore, A., & Jacobson Jr., C. J. (2008). Rapid assessment of access to primary care in remote parts of the developing world. *Field Methods, 20*(3), 296-309.

Bauze, A., Tran, L., Nguyen, K.-H., Firth, S., Jimenez-Soto, E., Dwyer Lindgren, L., . . . Lopez, A. (2012). Equity and geography: The case of child mortality in Papua New Guinea. *PloS One, 7*(5), e37861.

Blanford, J., Kumar, S., Luo, W., & MacEachren, A. (2012). It's a long, long walk: accessibility to hospitals, maternity and integrated health centers in Niger. *International Journal of Health Geographics, 11*(1), 24.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy, 80*, 223-255.

Grossman, M. (1972). *The Demand for Health: A Theoretical and Empirical Investigation.* New York: Columbia University Press for the National Bureau of Economic Research.

Hagerstrand, T. (1982). Diorama, path and project. *Tijdschrift voor Economische en Sociale Geografie, 73*(6), 323-339.

Kara, F., & Egresi, I. (2013). Accessibility of health care institutions: A case study by using GIS. *International Journal of Scientific Knowledge, 3*(4), 16-27.

McKinnon, B., Harper, S., Kaufman, J., & Abdullah, M. (2014). Distance to emergency obstetric services and early neonatal mortality in Ethiopia. *Tropical Medicine and International Health, 19*(7), 780-790.

McLaren, Z., Ardington, C., & Leibbrandt, M. (2014). Distance decay and persistent health care disparities in South Africa. *BMC Health Services Research, 14*(1), 541.

National Department of Health. (2011). *National Health Service Standards for Papua New Guinea 2011-2020.* Port Moresby: Government of Papua New Guinea.

Nesbitt, R., Gabrysch, S., Laub, A., Soremekun, S., Manu, A., Kirkwood, B., . . . Grundy, C. (2014). Methods to measure potential spatial access to delivery care in low- and middle-income countries: a case study in rural Ghana. *International Journal of Health Geographics, 13*(25), 1-13.

O'Donnell, O. (2007). Access to health care in developing countries: breaking down demand side barriers. *Cadernos de Saúde Pública, 23*(12), 2820-2834.

Picard, R. (2012, April 22). GEONEAR: Stata module to find nearest neighbors using geodetic distances. *Statistical Software Components, S457146*.

Rosero-Bixby, L. (2004). Spatial access to health care in Costa Rica and its equity: a GIS-based study. *Social Science & Medicine, 58*, 1271–1284.

Tanser, F., Hosegood, V., Benzler, J., & Solarsh, G. (2001). New approaches to spatially analyse primary health care usage patterns in rural South Africa. *Tropical Medicine and International Health, 6*(10), 826-838.

Weber, S., & Peclat, M. (2016). A simple command to calculate travel distance and travel time. *University of Neuchatel Institute of Economic Research Working Paper 16-10*, 1-10.

World Bank. (2013). *Transport in Papua New Guinea.* Washington DC: World Bank. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPTRANSPORT/0,,contentMDK:20768397~menuPK:2069483~pagePK:34004173~piPK:34003707~theSitePK:574066,00.html

World Health Organization. (2013). *Health Service Delivery Profile: Papua New Guinea, 2012.* Geneva: World Health Organization.

Table 1. Mode of Transportation for Most Recent Visit to Health Facility (%)

Male	*Urban*	*Rural*
Walk	42.5	73.9
Vehicle, private	18.8	2.5
Canoe	0.0	1.3
Boat	0.0	0.2
Bus	34.1	18.7
Other	4.6	3.4
No. observations	426	554
Female	*Urban*	*Rural*
Walk	42.0	73.9
Vehicle, private	16.5	2.6
Canoe	0.0	1.1
Boat	0.0	1.1
Bus	37.2	19.0
Other	4.3	2.5
No. observations	498	631

Note: Percentages are weighted and sample sizes are unweighted. Data represent mode of transportation for most recent visit to a health facility among individuals ages 15 and above. Based on the 2009-2010 Papua New Guinea HIES.

Table 2. Type of Health Facility Used (Past 30 Days) by Gender and Urban Status (%)

	Male		*Female*	
	Urban	*Rural*	*Urban*	*Rural*
Government hospital/clinic	49.8	24.3	52.4	25.0
Government health center	10.8	19.3	11.7	20.5
Government aid post	1.7	21.1	2.2	19.4
Mobile clinic	0.6	0.0	0.5	0.5
Community health worker	0.2	0.7	0.2	1.5
Church hospital	2.5	3.3	2.7	2.4
Church health center	5.0	21.5	5.8	20.7
Church aid post	3.5	6.9	3.0	7.3
Private hospital	9.9	0.5	11.1	0.8
Chemist/Drug store	3.2	1.1	3.2	0.6
Public health post	0.3	0.9	0.0	1.2
Private clinic/NGO	12.2	4.7	11.8	3.6
Traditional practitioner	0.6	0.9	1.0	0.4
Other	3.8	1.4	1.3	1.5
No. observations	375	470	382	535

Note: Percentages are weighted and sample sizes are unweighted. Percentages can add up to more than 100 since respondents can use more than one facility in the time period. Based on the 2009-2010 Papua New Guinea HIES. Responses are conditional on seeking treatment for a health problem.

Table 3. Health Care Facility Use (Past 30 Days) by Urban Status and Expenditure Quintile (%)

Urban	*Expenditure Quintile (last 12 months)*				
	1st (poorest)	*2nd*	*3rd*	*4th*	*5th (richest)*
Government hospital/clinic	1.8	3.7	4.5	8.7	32.5
Government health center	0.6	0.8	0.9	2.1	6.9
Government aid post	0.0	1.2	0.3	0.1	1.4
Mobile clinic	0.0	0.0	0.0	0.0	0.5
Community health worker	0.0	0.0	0.0	0.0	0.2
Church hospital	0.0	0.1	0.1	0.6	1.7
Church health center	0.3	0.1	0.3	1.2	3.6
Church aid post	0.0	0.0	0.7	0.9	1.7
Private hospital	0.6	0.2	0.3	0.8	8.7
Chemist/Drug store	0.0	0.1	0.1	0.1	2.8
Public health post	0.0	0.0	0.0	0.1	0.0
Private clinic/NGO	0.0	0.0	0.6	0.5	10.9
Traditional practitioner	0.0	0.1	0.0	0.0	0.6
Other	0.1	0.1	0.0	0.1	1.8
No. observations	24	43	56	118	516
Rural	*Expenditure Quintile (last 12 months)*				
	1st (poorest)	*2nd*	*3rd*	*4th*	*5th (richest)*
Government hospital/clinic	3.9	5.1	5.6	5.5	4.3
Government health center	3.3	4.5	3.9	5.1	3.1
Government aid post	6.4	4.0	4.2	2.3	3.2
Mobile clinic	0.1	0.0	0.0	0.0	0.1
Community health worker	0.2	0.4	0.2	0.3	0.0
Church hospital	0.3	0.6	0.7	0.6	0.7
Church health center	2.9	4.5	4.7	4.7	4.4
Church aid post	0.7	0.8	1.5	2.3	1.9
Private hospital	0.0	0.2	0.0	0.2	0.2
Chemist/Drug store	0.0	0.1	0.0	0.2	0.6
Public health post	0.0	0.3	0.7	0.0	0.0
Private clinic/NGO	0.2	0.9	0.5	1.5	1.1
Traditional practitioner	0.2	0.1	0.1	0.2	0.0
Other	0.1	0.2	0.0	0.7	0.4
No. observations	185	209	204	224	183

Note: Percentages are weighted and sample sizes are unweighted. Percentages can add up to more than 100 since respondents can use more than one facility in the time period. Based on the 2009-2010 Papua New Guinea HIES. Responses are conditional on seeking treatment for a health problem.

Table 4. Illness (Past 30 Days) Among Individuals Seeking Health Care, by Urban Status (%)

	Urban	*Rural*
Stomach Disorder	2.9	3.1
Cough	16.6	22.0
Cold	8.5	5.8
Back pain	10.2	21.2
Asthma	2.2	3.6
Stomach ache	4.1	6.2
Headache	12.3	24.0
Toothache	2.4	1.7
Ear pain	0.6	0.6
Diarrhea	2.9	2.6
Skin problem	2.2	2.7
Accident	1.1	0.5
Malaria	36.1	24.6
Pneumonia	1.6	1.3
Tuberculosis	1.8	0.7
Joint pain	7.2	16.3
Fever	5.1	10.6
Other	14.8	5.8
No. observations	757	1,005

Note: Percentages are weighted and sample sizes are unweighted. Percentages can add up to more than 100 since respondents can have more than one illness in the time period. Based on the 2009-2010 Papua New Guinea HIES. Responses are conditional on seeking treatment for a health problem.

Table 5. Reason for Not Seeking Treatment at a Health Facility for a Health Problem (Past 30 Days) by Urban Status (%)

	Urban	*Rural*
Not serious enough	31.6	27.2
Treated at home	58.3	33.0
Health facility too far	1.4	18.6
No transportation	0.3	0.7
Health care too expensive	3.2	7.5
Transport too expensive	0.3	1.7
Health workers unfriendly	0.1	0.4
Health workers not present	0.3	5.0
Health care not good quality	1.6	1.1
Other	4.2	4.9
No. observations	796	969

Note: Percentages are weighted and sample sizes are unweighted. Based on the 2009-2010 Papua New Guinea HIES.

Table 6. Sample Means, 2009-2010 HIES (% unless otherwise indicated)

	Total	*Urban*	*Rural*
Male	51.2	51.6	50.8
	(50.0)	(50.0)	(50.0)
Age	34.0	33.0	35.1
	(14.7)	(13.8)	(15.5)
Currently smokes	33.8	30.5	37.6
	(47.3)	(46.1)	(48.4)
Household expenditure quintiles			
Bottom	10.8	2.3	20.5
	(31.1)	(15.0)	(40.4)
2nd	12.3	4.8	20.9
	(32.9)	(21.4)	(40.6)
3rd	14.7	8.6	21.6
	(35.4)	(28.0)	(41.2)
4th	18.3	16.2	20.7
	(38.7)	(36.8)	(40.5)
Top	43.8	68.1	16.3
	(49.6)	(46.6)	(36.9)
Dwelling owned by hh	73.7	58.1	91.4
	(44.0)	(49.3)	(28.1)
Educational attainment			
Less than primary school	24.3	12.7	37.4
	(42.9)	(33.2)	(48.4)
Primary school	29.4	22.8	36.9
	(45.6)	(42.0)	(48.2)
Secondary school	31.1	41.6	19.3
	(46.3)	(49.3)	(39.5)
Tertiary school	15.2	23.0	6.4
	(35.9)	(42.1)	(24.4)
# working-age adults in hh	4.3	4.9	3.5
	(2.2)	(2.4)	(1.7)
# children in hh	2.4	2.5	2.3
	(1.8)	(1.9)	(1.7)
# elderly in hh	0.1	0.1	0.2
	(0.4)	(0.4)	(0.5)
Female headed hh	4.3	4.0	4.7
	(20.3)	(19.6)	(21.1)
HH has tap water	46.1	72.4	16.2
	(49.9)	(44.7)	(36.9)
HH has improved toilet	32.7	56.9	5.2
	(46.9)	(49.5)	(22.2)
Geographical region			

Southern	36.0	49.8	20.3
	(48.0)	(50.0)	(40.2)
Highland	22.5	9.9	36.8
	(41.8)	(29.9)	(48.2)
Momase	27.6	29.2	25.7
	(44.7)	(45.5)	(43.7)
Islands	13.9	11.1	17.2
	(34.6)	(31.4)	(37.7)
Urban	53.2	..	..
	(49.9)	..	..
Health and health facility usage			
Health complaint, past 30 days	28.0	23.5	33.1
	(44.9)	(42.4)	(47.0)
Visited health facility, past 30 days	51.8	51.3	52.2
	(50.0)	(50.0)	(50.0)
Hospitalized, past 12 months	4.5	4.3	4.7
	(20.7)	(20.3)	(21.1)
Distance and time to closest health facility			
# km (Euclidean)	19.3	16.3	22.7
	(21.6)	(16.3)	(26.0)
# km (roads)	18.7	16.5	21.8
	(22.5)	(15.6)	(29.3)
# minutes (roads, by vehicle)	25.1	23.5	27.2
	(38.8)	(28.4)	(49.7)
Sample Size	13,193	7,025	6,168

Note: Weighted values. Based on the 2009-2010 Papua New Guinea HIES. Sample size for *georoute* distance measures is 8,626 (5,022 in urban and 3,604 in rural areas). Standard deviations in parentheses.

Table 7. Summary of Key Dependent and Independent Variables

Variable	*Survey question*	*Condition*	*Definition*
Dependent			
Health complaints	Did you have any health complaints in the last 30 days?	None, asked of everyone in household	Yes=1, No=0
Health provider, past 30 days	In the past 30 days did you seek treatment at a health facility or provider for your health problems?	Asked of all household members conditional on reporting at least one health complaint in the past 30 days	Yes=1, No=0
Hospitalized, past 12 months	Have you been hospitalized, that is stayed one or more nights in a healthcare facility during the past 12 months?	None, asked of everyone in household	Yes=1, No=0
Independent			
Distance, Euclidean	NA	HIES household matched to nearest neighboring health facility in OCHA data set using Euclidean distance (*geodist*)	Kilometers
Distance, Stata-generated	NA	HIES household matched to nearest neighboring health facility in OCHA data set using shortest route (*georoute*)	Kilometers
Time, Stata-generated	NA	HIES household matched to nearest neighboring health facility in OCHA data set using shortest route, estimated travel time based on route (*georoute*)	Minutes

Table 8. Logit Estimates for Whether Individual Reported a Health Complaint in Past 30 Days

	Total			*Urban*			*Rural*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Male	0.807***	0.770***	0.770***	0.854***	0.872*	0.873*	0.797***	0.748***	0.748***
	(0.042)	(0.051)	(0.051)	(0.051)	(0.061)	(0.061)	(0.048)	(0.059)	(0.059)
Age	1.028***	1.028***	1.028***	1.026***	1.026***	1.026***	1.028***	1.028***	1.028***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Currently smokes	1.110*	1.259***	1.259***	0.992	0.998	0.995	1.123*	1.302***	1.302***
	(0.066)	(0.096)	(0.096)	(0.071)	(0.084)	(0.084)	(0.076)	(0.116)	(0.116)
Household expenditure quintiles (ref: top quintile)									
Bottom	0.871	0.996	0.996	0.712	0.611	0.602	0.870	1.013	1.016
	(0.117)	(0.181)	(0.181)	(0.209)	(0.229)	(0.228)	(0.130)	(0.202)	(0.203)
2nd	0.877	0.881	0.880	0.940	1.013	1.017	0.876	0.882	0.885
	(0.106)	(0.133)	(0.133)	(0.176)	(0.244)	(0.245)	(0.120)	(0.150)	(0.151)
3rd	0.803*	0.733**	0.731**	0.852	0.851	0.847	0.800*	0.725*	0.728*
	(0.094)	(0.106)	(0.106)	(0.121)	(0.140)	(0.139)	(0.107)	(0.120)	(0.121)
4th	0.963	0.839	0.837	0.938	1.015	1.015	0.969	0.815	0.816
	(0.107)	(0.113)	(0.113)	(0.107)	(0.136)	(0.135)	(0.128)	(0.132)	(0.132)
Dwelling owned by hh	0.855	0.771**	0.772**	0.791**	0.848	0.846	0.895	0.729*	0.721*
	(0.086)	(0.095)	(0.095)	(0.073)	(0.089)	(0.089)	(0.129)	(0.140)	(0.138)
Educational attainment (ref: less than primary)									
Primary school	0.919	0.871	0.872	0.992	0.926	0.923	0.911	0.862	0.864
	(0.064)	(0.081)	(0.081)	(0.104)	(0.121)	(0.120)	(0.068)	(0.089)	(0.089)
Secondary school	0.899	0.981	0.983	0.911	0.904	0.902	0.902	0.995	0.995
	(0.077)	(0.106)	(0.106)	(0.096)	(0.119)	(0.118)	(0.089)	(0.125)	(0.125)
Tertiary school	0.753***	0.859	0.859	0.914	0.926	0.921	0.717**	0.854	0.851
	(0.081)	(0.114)	(0.114)	(0.108)	(0.133)	(0.132)	(0.102)	(0.156)	(0.155)
# working-age adults in hh	0.925***	0.924***	0.923***	0.974	0.965	0.965	0.909***	0.912***	0.912***
	(0.019)	(0.024)	(0.024)	(0.018)	(0.022)	(0.022)	(0.024)	(0.031)	(0.031)
# children in hh	0.958**	0.952**	0.952**	0.979	0.973	0.972	0.954**	0.949*	0.949*

	(0.019)	(0.023)	(0.023)	(0.025)	(0.029)	(0.029)	(0.022)	(0.027)	(0.027)
# elderly in hh	0.883	0.893	0.893	0.826*	0.824	0.824	0.881	0.892	0.891
	(0.070)	(0.085)	(0.086)	(0.096)	(0.111)	(0.111)	(0.077)	(0.094)	(0.094)
Female headed hh	1.011	1.136	1.137	1.130	1.085	1.081	0.973	1.113	1.113
	(0.123)	(0.171)	(0.171)	(0.162)	(0.182)	(0.182)	(0.134)	(0.193)	(0.193)
HH has tap water	1.128	1.020	1.013	1.104	1.312**	1.312**	1.130	0.972	0.969
	(0.105)	(0.125)	(0.123)	(0.116)	(0.178)	(0.178)	(0.125)	(0.142)	(0.142)
HH has improved toilet	1.284**	1.241	1.229	0.832*	0.806*	0.803*	1.719***	1.615**	1.606**
	(0.157)	(0.179)	(0.176)	(0.090)	(0.100)	(0.099)	(0.324)	(0.366)	(0.360)
Geographical region (ref=Southern)									
Highlands	0.844*	0.865	0.877	0.758*	0.766*	0.807	0.851	0.877	0.866
	(0.086)	(0.124)	(0.129)	(0.112)	(0.118)	(0.125)	(0.105)	(0.180)	(0.186)
Momase	1.159	0.964	0.986	1.175	1.472***	1.571***	1.182	0.942	0.937
	(0.112)	(0.152)	(0.160)	(0.116)	(0.199)	(0.217)	(0.150)	(0.215)	(0.225)
Islands	1.070	1.099	1.103	1.177	1.041	1.134	1.076	1.110	1.079
	(0.118)	(0.182)	(0.187)	(0.150)	(0.153)	(0.167)	(0.142)	(0.262)	(0.264)
Urban	0.540***	0.589***	0.594***	..	..	..	..	..	..
	(0.055)	(0.078)	(0.078)	..	..	..	..	..	..
Distance and time to closest health facility									
# km (Euclidean)	1.004**			1.001			1.004**		
	(0.002)			(0.003)			(0.002)		
# km (roads)		1.002			1.011***			1.002	
		(0.002)			(0.003)			(0.002)	
# minutes (roads)			1.001			1.006***			1.001
			(0.001)			(0.001)			(0.001)
Sample Size	13,071	8,548	8,548	6,948	4,976	4,976	6,123	3,572	3,572

Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is p <0.01, ** is p <0.05, * is p <0.10. Sample is all individuals in the HIES ages 15 and up with observed values for distance and time to health facility.

Table 9. Logit Estimates for Whether Individual with a Health Complaint Visited Health Facility in Past 30 Days

	Total			*Urban*			*Rural*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Male	0.894	0.904	0.911	1.155	1.274*	1.276**	0.854*	0.833	0.841
	(0.075)	(0.101)	(0.101)	(0.122)	(0.158)	(0.158)	(0.081)	(0.109)	(0.110)
Age	1.004	1.004	1.004	0.998	0.998	0.998	1.005	1.004	1.004
	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.003)	(0.005)	(0.005)
Currently smokes	0.857*	0.980	0.975	0.873	0.808	0.811	0.866	1.029	1.025
	(0.079)	(0.120)	(0.119)	(0.109)	(0.121)	(0.121)	(0.089)	(0.147)	(0.145)
Household expenditure quintiles (ref: top quintile)									
Bottom	0.522***	0.365***	0.366***	1.952	5.532*	5.505*	0.517***	0.367***	0.372***
	(0.110)	(0.105)	(0.104)	(1.260)	(5.511)	(5.475)	(0.121)	(0.116)	(0.117)
2nd	0.876	0.873	0.882	1.065	1.085	1.073	0.872	0.905	0.925
	(0.170)	(0.205)	(0.206)	(0.327)	(0.401)	(0.395)	(0.189)	(0.241)	(0.244)
3rd	0.858	1.040	1.047	0.664	0.841	0.844	0.856	1.078	1.101
	(0.169)	(0.256)	(0.255)	(0.165)	(0.246)	(0.247)	(0.190)	(0.304)	(0.306)
4th	0.876	1.138	1.148	0.817	0.766	0.767	0.876	1.206	1.230
	(0.155)	(0.240)	(0.242)	(0.160)	(0.167)	(0.168)	(0.183)	(0.308)	(0.314)
Dwelling owned by hh	0.908	0.884	0.875	1.017	0.895	0.893	0.965	1.053	1.030
	(0.149)	(0.177)	(0.174)	(0.145)	(0.150)	(0.149)	(0.225)	(0.332)	(0.323)
Educational attainment (ref: less than primary)									
Primary school	1.215*	1.264	1.257	0.785	0.817	0.821	1.255*	1.322	1.313
	(0.136)	(0.205)	(0.203)	(0.137)	(0.176)	(0.177)	(0.150)	(0.237)	(0.234)
Secondary school	1.181	1.087	1.075	0.812	0.750	0.749	1.208	1.103	1.081
	(0.165)	(0.201)	(0.197)	(0.150)	(0.168)	(0.167)	(0.191)	(0.235)	(0.230)
Tertiary school	1.158	1.095	1.087	0.863	0.716	0.719	1.170	1.161	1.136
	(0.201)	(0.249)	(0.247)	(0.166)	(0.164)	(0.165)	(0.267)	(0.361)	(0.355)
# working-age adults in hh	0.964	0.934	0.935	0.982	0.951	0.952	0.956	0.921	0.924
	(0.033)	(0.040)	(0.040)	(0.028)	(0.031)	(0.031)	(0.041)	(0.051)	(0.051)
# children in hh	1.008	1.059	1.057	1.101***	1.178***	1.178***	0.996	1.037	1.032

	(0.032)	(0.043)	(0.043)	(0.036)	(0.047)	(0.047)	(0.037)	(0.051)	(0.051)
# elderly in hh	1.064	1.090	1.087	0.960	0.962	0.960	1.066	1.105	1.099
	(0.137)	(0.174)	(0.173)	(0.194)	(0.225)	(0.225)	(0.148)	(0.198)	(0.196)
Female headed hh	0.875	0.918	0.916	0.868	0.716	0.715	0.858	0.924	0.919
	(0.159)	(0.212)	(0.212)	(0.207)	(0.215)	(0.215)	(0.174)	(0.244)	(0.242)
HH has tap water	1.023	0.980	0.995	1.187	0.982	0.969	1.033	1.019	1.050
	(0.144)	(0.183)	(0.186)	(0.194)	(0.218)	(0.214)	(0.170)	(0.228)	(0.237)
HH has improved toilet	1.053	1.292	1.314	0.757*	0.823	0.828	1.367	1.753	1.870
	(0.201)	(0.298)	(0.301)	(0.124)	(0.157)	(0.157)	(0.412)	(0.713)	(0.771)
Geographical region (ref=Southern)									
Highlands	0.766*	0.713	0.676*	1.685**	1.752**	1.698**	0.692**	0.532**	0.476**
	(0.119)	(0.151)	(0.146)	(0.378)	(0.419)	(0.410)	(0.128)	(0.171)	(0.159)
Momase	0.828	0.602**	0.543**	1.253	1.128	1.082	0.765	0.446**	0.375***
	(0.125)	(0.148)	(0.134)	(0.195)	(0.255)	(0.250)	(0.146)	(0.165)	(0.142)
Islands	0.675**	0.561**	0.542**	1.206	1.052	1.000	0.612**	0.412**	0.375***
	(0.110)	(0.139)	(0.136)	(0.246)	(0.261)	(0.256)	(0.118)	(0.148)	(0.139)
Urban	0.708**	0.610**	0.599***	..	..	..	..	..	..
	(0.107)	(0.121)	(0.119)	..	..	..	..	..	..
Distance and time to closest health facility									
# km (Euclidean)	1.001			1.002			1.000		
	(0.002)			(0.004)			(0.002)		
# km (roads)		0.993**			0.995			0.992**	
		(0.003)			(0.004)			(0.003)	
# minutes (roads)			0.997**			0.997			0.995**
			(0.002)			(0.002)			(0.002)
Sample Size	3,655	2,276	2,276	1,631	1,163	1,163	2,024	1,113	1,113

Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is p <0.01, ** is p <0.05, * is p <0.10. Sample is all individuals in the HIES ages 15 and up with observed values for distance and time to health facility.

Table 10. Logit Estimates for Whether Individual was Hospitalized in Past Year

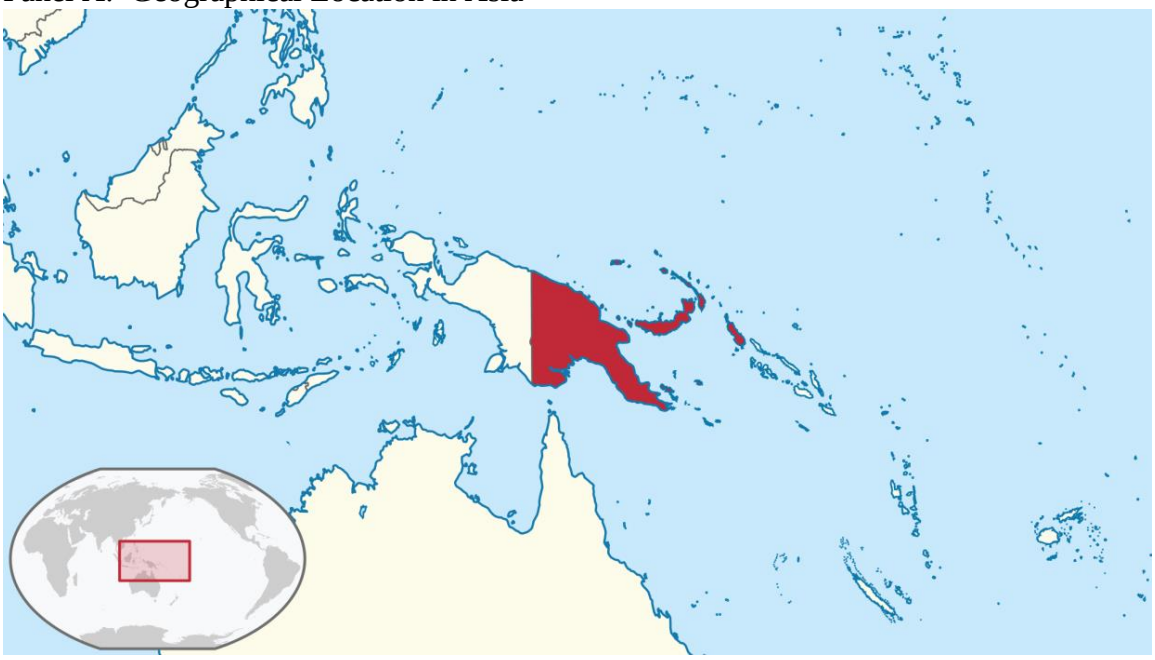
	Total			*Urban*			*Rural*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Male	0.475***	0.402***	0.402***	0.373***	0.385***	0.385***	0.495***	0.404***	0.404***
	(0.058)	(0.065)	(0.065)	(0.053)	(0.061)	(0.061)	(0.070)	(0.078)	(0.078)
Age	1.002	1.002	1.002	1.006	1.007	1.007	1.001	1.001	1.001
	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
Currently smokes	1.105	1.170	1.170	1.116	0.982	0.982	1.097	1.210	1.210
	(0.133)	(0.180)	(0.180)	(0.164)	(0.166)	(0.166)	(0.151)	(0.217)	(0.217)
Household expenditure quintiles (ref: top quintile)									
Bottom	0.424***	0.421***	0.419***	0.811	1.112	1.100	0.410***	0.403***	0.400***
	(0.094)	(0.130)	(0.129)	(0.365)	(0.544)	(0.535)	(0.098)	(0.134)	(0.133)
2nd	0.640**	0.723	0.719	0.867	0.734	0.739	0.617**	0.711	0.708
	(0.125)	(0.175)	(0.174)	(0.273)	(0.268)	(0.269)	(0.131)	(0.186)	(0.185)
3rd	0.722*	0.680*	0.675*	0.828	0.634	0.629	0.694*	0.672	0.667
	(0.135)	(0.158)	(0.158)	(0.201)	(0.194)	(0.192)	(0.143)	(0.171)	(0.169)
4th	0.675**	0.534***	0.533***	0.850	0.974	0.977	0.641**	0.477***	0.477***
	(0.118)	(0.116)	(0.116)	(0.159)	(0.200)	(0.200)	(0.129)	(0.123)	(0.123)
Dwelling owned by hh	1.090	0.981	0.989	1.038	0.981	0.979	1.129	0.991	0.997
	(0.183)	(0.180)	(0.180)	(0.157)	(0.161)	(0.160)	(0.273)	(0.288)	(0.285)
Educational attainment (ref: less than primary)									
Primary school	1.047	1.143	1.138	0.995	0.965	0.965	1.029	1.144	1.138
	(0.158)	(0.221)	(0.221)	(0.210)	(0.239)	(0.239)	(0.169)	(0.245)	(0.244)
Secondary school	1.158	1.275	1.269	1.140	1.065	1.062	1.137	1.286	1.273
	(0.202)	(0.281)	(0.279)	(0.244)	(0.268)	(0.267)	(0.225)	(0.329)	(0.326)
Tertiary school	0.779	0.962	0.963	0.987	0.996	0.989	0.692	0.893	0.893
	(0.170)	(0.265)	(0.266)	(0.226)	(0.263)	(0.262)	(0.209)	(0.355)	(0.356)
# working-age adults in hh	0.868***	0.910**	0.912**	0.891***	0.910**	0.909**	0.860***	0.910	0.914
	(0.033)	(0.042)	(0.043)	(0.030)	(0.035)	(0.035)	(0.042)	(0.058)	(0.058)
# children in hh	1.001	1.012	1.011	1.098***	1.101**	1.099**	0.981	0.990	0.988

	(0.033)	(0.041)	(0.041)	(0.036)	(0.044)	(0.043)	(0.039)	(0.051)	(0.051)
# elderly in hh	0.894	0.765	0.764	0.988	0.740	0.741	0.873	0.765	0.765
	(0.136)	(0.139)	(0.139)	(0.181)	(0.152)	(0.152)	(0.148)	(0.154)	(0.155)
Female headed hh	1.473*	1.815**	1.812**	1.299	1.453	1.449	1.472*	1.859**	1.854**
	(0.303)	(0.437)	(0.436)	(0.313)	(0.390)	(0.390)	(0.345)	(0.520)	(0.518)
HH has tap water	0.881	0.605**	0.611**	0.963	0.914	0.903	0.879	0.594**	0.602**
	(0.139)	(0.125)	(0.126)	(0.166)	(0.207)	(0.199)	(0.167)	(0.154)	(0.154)
HH has improved toilet	1.197	1.282	1.302	0.936	0.972	0.970	1.464	1.411	1.459
	(0.248)	(0.307)	(0.314)	(0.158)	(0.192)	(0.191)	(0.409)	(0.477)	(0.491)
Geographical region (ref=Southern)									
Highlands	0.697**	0.755	0.737	0.856	0.844	0.887	0.660**	0.659	0.636
	(0.120)	(0.162)	(0.158)	(0.213)	(0.222)	(0.238)	(0.133)	(0.185)	(0.177)
Momase	0.652**	0.682	0.654*	1.125	1.175	1.239	0.580**	0.561	0.532*
	(0.110)	(0.174)	(0.168)	(0.174)	(0.257)	(0.280)	(0.130)	(0.198)	(0.187)
Islands	1.435**	1.228	1.237	1.448*	1.606**	1.740**	1.403*	1.032	1.035
	(0.247)	(0.293)	(0.294)	(0.293)	(0.360)	(0.386)	(0.289)	(0.328)	(0.325)
Urban	0.830	0.870	0.863	..	..	..	..	..	..
	(0.137)	(0.182)	(0.180)	..	..	..	..	..	..
Distance and time to closest health facility									
# km (Euclidean)	1.001			0.993*			1.002		
	(0.003)			(0.004)			(0.003)		
# km (roads)		0.992**			1.010**			0.990**	
		(0.004)			(0.005)			(0.005)	
# minutes (roads)			0.996			1.005**			0.994
			(0.003)			(0.002)			(0.004)
Sample Size	13,098	8,566	8,566	6,956	4,981	4,981	6,142	3,585	3,585

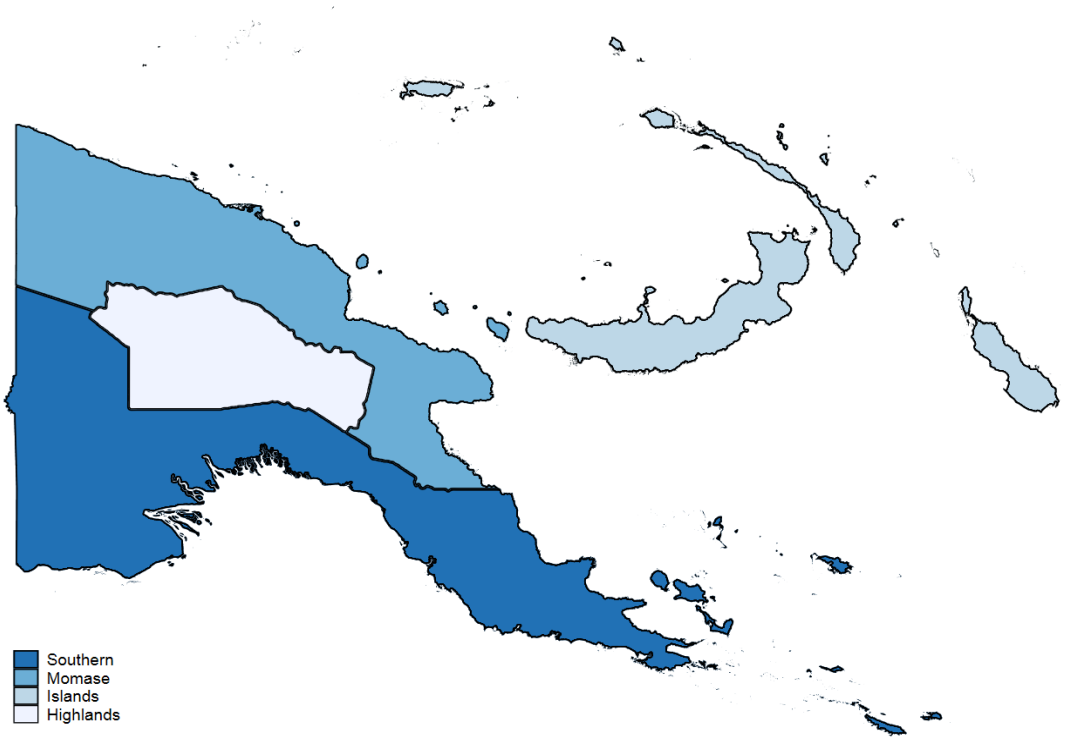
Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is p <0.01, ** is p <0.05, * is p <0.10. Sample is all individuals in the HIES ages 15 and up with observed values for distance and time to health facility.

Figure 1. Papua New Guinea: Geographical Location and Regions

Panel A: Geographical Location in Asia



Panel B: Papua New Guinea by Regions



Sources: Panel A is from the Wikimedia Commons. Panel B is generated by the authors using GIS data from OCHA.

Figure 2. Households, Health Facilities, and Road Network in Papua New Guinea

Note: The map depicts regional borders and roadways as dark lines. Households and health facilities are clustered together and are represented as dark and light gray circles. Map generated by authors using HIES and OCHA data.