RESEARCH ARTICLE

Joint Families and Cancer Diagnosis in Rural India

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Abstract

Background: Each year, there are over a million new cases of cancer in India, which causes many untimely deaths and increases the economic burden to households. By focusing on preventative measures and finding socioeconomic and behavioral contributors to cancer, steps can be taken to help alleviate this burden. This study aims to find the effect living in a joint family can have on being diagnosed with cancer in rural India. **Methods:** The study estimates the effect living in a joint family, along with other demographic information, has on being diagnosed with cancer using a logit estimation model. The data for the study was collected from a survey was conducted on the households of the Handiganur village (N=251) comprising of several demographic, social, and medical questions. **Results:** The study found that living in a joint family lowers the odds of having cancer. The results indicate that living in a joint family reduces the probability of being diagnosed by 7.23 percentage points and is significant at a 5% level. Furthermore, among the other tested variables, eating habit is negatively significant at 5% level, suggesting that if a person eats 3 to 4 times a day his or her likelihood of suffering from cancer will be lowered by 6.55 percentage points. Access to public wells and drinking alcohol both increase the likelihood of being diagnosed with cancer by 7.90 (p<0.1) percentage points and 11.90 (p<0.05) percentage points respectively. **Conclusions:** The negative effect of joint family could be due to two possible reasons. The first is that there is in fact a biological reason. The second reason for this result could be a false negative, as it could be because people in joint families are not getting the necessary check-ups required to diagnose cancer.

Keywords: Joint families- cancer- logit- eating habits

Introduction

Cancer has long been the global source of grief for many families. The number of deaths from cancer is about 8.2 million per year and the annual projected number is to continue to increase to 13.1 million by 2030 (WHO, 2016). In Association of Southeast Asian Nations alone, the cancer related deaths lead to a loss of 7.5 million disability adjusted life years (Kimman et al., 2012). In India, over one million cases of cancer is diagnosed each year, while deaths attributed to cancer reaches 700,000 annually (Mallath et al., 2014). However, the cause of this grief is not just the sheer number of annual deaths. Cancer also creates psychological distress to the patient's household (Adler et al., 2008). In fact, as cancer treatment proceeds, meta-analysis has shown that the stress that a patient feels is positively correlated with their caretakers (Hodges et al., 2005).

In addition to the emotional and psychological burdens that caregivers face, they are also burdened with the economic cost of taking care of the cancer patient. Households that have members with cancer not only spend on average more on healthcare per member, but also have a lower adult workforce participation rate, as well as higher rates of borrowing money in order to pay for

treatments (Mahal et. al., 2013). In the United States, the cost of informal care, care given by household members or other caregivers and measured by taking into account the time spent on the care, averaged to approximately $1200 annually per patient (Hayman et. al., 2001). Even for those in remission, costs are higher after cancer, with men and women paying $4,187 and $3,293 more respectively for healthcare compared to those that never had cancer (Ekwueme et al., 2014). Furthermore, the burden is intensified for those that are at a disadvantage socioeconomically, with the poor being more susceptible to cancer related deaths (Mallath et al., 2014).

The effect family has on cancer treatment has been well documented (Northouse et al., 2005; Schumacher et al., 2008), as has the effect of cancer treatments on families (Dockerty et al., 2003; Hayman et al., 2001; Hodges et al., 2005). There is little literature, however, on the effect that different family sizes and different types of families (joint or nuclear) can have on a person's likelihood in developing cancer. As many Asian household are typically arranged as joint families multiple generations living in the same house as opposed to nuclear families immediate family consisting only of the parents and kids living in the same house, studying this effect would have significant implications for health in Asia. The focus of this study,

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specifically, is on the type of family: whether the surveyed live in nuclear family or a joint family. Furthermore, in addition to studies implicating behaviors, such as smoking or drinking, that will raise or lower an individual's likelihood of developing cancer (Blot et al., 1988), studies are being done to show the effects certain environmental factors such as using water from private wells can have on developing cancer. Studies from Córdoba (Aballay et al., 2012) and Florida (Liu-Mares et al., 2013) have shown a strong link between public wells and cancer. Similarly, this study focuses on other daily activities performed by a typical Indian household, and how they affect the rate of being diagnosed with cancer.

Studies have also shown the impact of eating habits on developing cancer. Eating certain types of meals, such as Western diets high in red meat and refined grain, had a higher incidence of colon cancer (Slattery et al., 1998). Additionally, eating habits and high caloric intake leading to obesity has shown to increase the likelihood of being diagnosed with pancreatic cancer (Silverman et al. 1998). To this date, however, no such study has been conducted to analyze the effect living in joint family can have on being diagnosed with cancer. As such, this study aims to fill a significant gap in the current literature in regards to this area of research. This study did not explore the types of cancer and its relation to family types. While estimating the effect of types of family, it estimated the likelihood of suffering cancer if a person is living in joint family system.

Materials and Methods

Methodology

This study employs data collected through a questionnaire based survey conducted at Handiganur village, located in the southwestern state of Karnataka in India. The survey, conducted by Karnataka Lingiat Educational (KLE) Society University from January 16 to February 5, 2015, contains a total of 251 observations consisting of randomly selected households.

In order to estimate the effect of living in a joint family on being diagnosed with cancer, the study uses a concept developed by Lalonde (1974). The production of health is broadly determined by the healthcare system available in the country , environmental factors , lifestyle factors , human biology and the other factors (z), which includes the variable joint family, the main variable of this study. Hence the health production function is given as:

$$y_i = f(\mathbf{h_i}, \mathbf{e_i}, \mathbf{l_i}, \mathbf{b_i}, \mathbf{z_i}) \quad (1)$$

Since the study is based on the primary data obtained from a rural part of India, which does not have any government run health care system, this paper only captures the effect of joint family (JFAMILY), environmental factor such as access to a public well, life style factor such as smoking, alcohol, and eating habits, and other factors such as age, income, high school level education, and sex. Each of these factors may have either positive or negative impact on health outcome.

To estimate the impact of each of those variables on health outcome, a binary variable, this study uses the

binary dependent variable models. As the dependent variable is binary, either a logit or probit model, or a linear probability model (LPM) can be used. This study uses a logit model to estimate the likelihood of being diagnosed with cancer; however, due to a growing trend in using linear probability models on binary dependent variables to estimate likelihood (Hellevik, 2007), this study also employs a linear probability model to check for consistency with the findings of the logit estimation. Each model has its strengths and weakness. For example, the predicted probability using LPM might be greater than 1 or less than 0, which is not mathematically meaningful. Furthermore, as Greene (2002) notes that using LPM can lead to biased estimates, this study uses the LPM only for comparison, while the results of logit estimation are used for analysis. The dependent variable is discrete and has binary outcomes: if a person is diagnosed with a cancer then the observed values is represented as "1" and if not then it is "0". Logit estimation determines the odds of some event happening (e.g. Y=1), which is defined as the probability of that event occurring divided by the probability of the specified event not occurring. That is, the odds of effect, E [Yi] = Pr (Yi =1) is given by

$$\Pr(Y_i = 1) = \frac{\exp\{\beta' X_i\}}{1 + \exp\{\beta' X_i\}} \quad (2)$$

In equation (2), Xi represents a vector of attributes mentioned in equation (1) and β is a vector of corresponding coefficients. Further, the study also estimates the marginal effects of the explanatory variables. The marginal effect estimated as $\Pr(Y = 1 | X, X_k = 1) - \Pr(Y = 1 | X, X_k = 0)$ if the explanatory variable is a categorical variable and

$\Pr(Y = 1 | X) * \Pr(Y = 0 | X) * \hat{\beta}_k$ if the explanatory variable is continuous. The equation (2) estimates the value of the dependent variable for this model: the likelihood of being diagnosed with cancer. Although the linear probability model (LPM) is used only for a comparison purpose, it can be written as:

$$y_i = \beta_0 + \hat{\mathbf{a}}_j \mathbf{x}_{ji} + \varepsilon_i \quad (3)$$

In equation (3), is the vector of attributes that includes living in a joint family, life style, environmental, and other factors stated in equation (1) above. The   is the effect of the jth variable, holding other factors in the equation (3) constant.

A total of nine variables are controlled, with the choices of explanatory variables being made based on the objective of study and variables that affect the household behavior, as suggested by Lalonde (1974). Several studies have revealed that demography, life styles, types of water sources (or environmental pollution) and level of education, etc. have contributed in developing cancer (Pellegriti et al., 2013; Mills et al., 1989). Similarly, this study also divided the controlled variables into three different categories: demographics, lifestyle, and miscellaneous. Under demographics the variables

Table 1. Descriptive Statistics

Variable	Definition	Mean	St. Dev.
CANCER	If a person is a cancer patient	0.111	0.315
lnAGE	The natural log of the person's age	4.22	0.244
FEMALE	Whether the person is a female (and assigned a value of 1) or male (assigned a value of 0)	0.496	0.5
lnINCOME	The natural log of the household income measured in Indian Rupees	8.216	0.669
EHABIT	The eating habit of the person, a binary variable (1 if a person eats either 3 or 4 times a day, 0 otherwise).	0.163	0.37
JFAMILY	Whether the person lives in a joint family, a binary variable (1 if joint family, 0 otherwise).	0.214	0.411
PUBWELL	Whether the household accesses its water from a public well (1 if yes, 0 otherwise).	0.29	0.454
SMOKING	Whether the person smokes (1 if Yes 0 otherwise).	0.192	0.395
ALCHOHOL	Whether the person drinks (1 if Yes 0 otherwise).	0.251	0.434
HSCHOOL	Whether the person has attended high school (1 if Yes 0 otherwise).	0.167	0.374

N, 251

controlled are i) the natural log of the age of the person (lnAGE), ii) whether the person is female (FEMALE) (given a value of 1) or male (a value of 0), iii) natural log of household income (lnINCOME), and iv) joint family (JFAMILY). The variable JFAMILY is a binary one where 1 signifies that the person lives in a joint family, and 0 represents individual not living in a joint family. The category of lifestyles consists: i) eating habit (EHABIT) a binary variable that represents the eating habit of the individual, where a value of 1 signifies three to four meals a day and 0 otherwise. Similarly, smoking (SMOKING) describes whether the individual is a smoker, with 1 representing that he or she is. Lastly, if a person drinks alcohol (ALCHOHOL), they are given a 1, representing that he or she does. The last category, miscellaneous, contains two variables. If a household has access to water from a public well (PUBWELL), they are given a 1, meaning that they do and "0" otherwise. A person's high school attendance is represented as well (HSCHOOL), with 1 meaning that they have. For variable definition and descriptive statistics refer to Table 1.

Results

This study estimates the likelihood of being diagnosed with cancer using a logit estimation model and a linear probability model, which has a pseudo R^2 of 0.12 and an R^2 of 0.11, respectively. The results are presented in Table 2. Furthermore, the study also looks at the marginal effects of the logit estimation of each explanatory variable, the results of which are given in Table 3. The results of the linear probability model are consistent with the logit estimation model, and are primarily used for comparison purpose only. Therefore, analyses in the result and discussion sections are done using the results from the logit estimation and its marginal effects.

The result shows that out of nine controlled explanatory variables three of appeared significant and six variables appear not significant. Among the significant ones, the variable JFAMILY is significant at 5% level with a value -1.293. This finding suggests that if a person who lives in a joint family, he or she will have a lower probability of being diagnosed with cancer. Other three variables those appeared significant are: EHABIT, with a coefficient of -1.23 and being significant at the 10% level, PUBWELL,

with a coefficient of 0.933 and being significant at the 5% level, and ALCOHOL, with a coefficient of 1.260 and being significant at the 1% level. All variables that are significant in logit estimation are also significant in linear probability model (LPM) with the same sign as well, revealing a consistency in the findings (see Table 2 for detail). Among the insignificant variables are: lnAGE, FEMALE, lnINCOME, SMOKING, and HSCHOOL. Of these, lnAGE, FEMALE, and lnINCOME all had negative coefficients, but were not significant. The two remaining variables, SMOKING and HSCHOOL, appeared insignificant with positive coefficients.

The study also estimated the marginal effects of the controlled variables. From policy perspective, estimating the marginal effect is important. The marginal effect of

Table 2. Estimates of Logit Model and Linear Probability Model

Variable	Logit Coefficient (Std. Err.)	Linear Coefficient (Std. Err.)
INTERCEPT	-1.048	0.162
	(4.185)	(0.277)
lnAGE	-0.059	0.002
	(0.701)	(0.032)
FEMALE	-0.365	-0.029
	(0.431)	(0.039)
lnINCOME	-0.16	-0.011
	(0.43)	(0.032)
EHABIT	-1.23*	-0.080**
	(0.672)	(0.039)
JFAMILY	-1.293**	-0.081**
	(0.82)	(0.039)
PUBWELL	0.933**	0.097**
	(0.438)	(0.048)
SMOKING	0.673	0.055
	(0.602)	(0.053)
ALCOHOL	1.260***	0.115**
	(0.484)	(0.051)
HSCHOOL	0.568	0.063
	(0.533)	(0.062)

Pseudo R^2, 0.12, N, 251; Note: *, ** and *** represent significant at 10%, 5% and 1% level.

Table 3. Estimates of Marginal Effect of Logit Model

Variable	Marginal Effects	Std. Err.
INTERCEPT	--	--
lnAGE	-0.004	0.05
FEMALE	-0.026	0.032
lnINCOME	-0.012	0.031
EHABIT	-0.065**	0.029
JFAMILY	-0.0723**	0.033
PUBWELL	0.079*	0.042
SMOKING	0.057	0.062
ALCOHOL	0.119**	0.053
HSCHOOL	0.048	0.054

N, 251; Note, *, ** and *** represent significant at 10%, 5% and 1% level

the variable JFAMILY is -0.0723 and is significant at the 5% level, which suggests that the probability of being diagnosed with cancer will be reduced by 7.23 percentage points if a person lives in a joint family, compared to those not living in a joint family. The marginal effect of eating habit (EHABIT) is negatively significant at 5% level. This study finds that if a person eats 3 to 4 times a day his or her likelihood of suffering from cancer will be lowered by 6.55 percentage points. The drinking water sources variable PUBWELL had a positive coefficient of 0.079 and was significant at the 10% level. Result shows that if a household uses water from public well, the likelihood of diagnose with cancer increase by 7.90 percentage point. Similarly, this study finds drinking alcohol (ALCOHOL) also contributes to increase the probability of diagnose cancer by 11.90 percentage points, which is significant at the 5% level. Unlike drinking the alcohol, the smoking habit (SMOKING) remained insignificant, but kept the positive effect. The education level variable if the individual has at least high school degree (HSCHOOL) also appeared not significant. Results show that all other remaining variables: natural log of income (lnINCOME) and natural log of individual age (lnAGE), both were insignificant at even a 10% level, and all had negative coefficients, which are presented in detail in Table 3.

Discussion

The study finds that the log of odds of being diagnosed and the probability of being diagnosed for a unit change in living in a joint family (JFAMILY) is significant and negative. The negative coefficient value suggests that living in a joint family lowers the probability that an individual will be diagnosed with cancer. The negative value of the marginal effect also confirms this finding. This finding is consistent with the results of linear probability model in terms of sign and significance level. There have been studies that have linked lower cancer risk with bigger family sizes (Hemminki et al., 2001). The results of this study could stem from a combination of different reasons, both biological and economical. Studies have also shown that the birth order affects the risk of cancer and that there is a negative relation between birth order and cancer risk (Bevier et al., 2011). However, the result of

both studies were marginally significant with a population size of over 5 million, indicating that there are other factors contributing to the negative coefficient of being in a joint family.

Another reason for the lower probability of diagnosis is entirely economical. Being in a joint family means that the income of the family is more spread among each family member, leaving less money for personal needs. It can be argued that the lower likelihood of being diagnosed with cancer, therefore, does not necessarily mean that living in a joint family lowers the risk of developing cancer. Instead, living in a joint family lowers the resources available to its members to make visits to a medical facility in order to get diagnosed. The village of Handiganur, where the data was collected, has a lower per household income compared to the rest of India, with the average monthly household income being approximately 3,700 Rupees for Handiganur, and the average monthly household income being approximately 6,700 Rupees for all of India (World Bank, 2017). This shows that the average per capita income per head in this particular village was far lower than the average per capita income of India as a nation. Furthermore, even though the natural log of income (lnINCOME) has a positive correlation with number of yearly hospitalizations, being in a joint family had a negative relation. This supports the claim that living in a joint family decreases the likelihood of seeking proper medical care in order to get diagnosed with cancer. Additionally, this can be seen in the US, as women at a lower socioeconomic level tend to be diagnosed at a later stage that those with more resources available to them (Wells et al., 1992). As such, the negative marginal effect of joint family on cancer diagnosis could be just that, a lower probability of being diagnosed and discovering the cancer, as opposed to lowering the actual probability of developing cancer.

This study also examined the effects of other variables, particularly those will be of interest to both health practitioners as well as policy makers. Of the controlled variables that were significant, both alcohol consumption (ALCOHOL) and drinking water from public well (PUBWELL) had significant effects, suggesting that consuming alcohol, or relying on a public well as opposed to having access to a private water supply increases the likelihood of cancer in individuals by 11.86% and 7.93%, respectively. The positive effect of alcohol in increasing the probability seems intuitive, and studies have linked a causal effect between alcohol and many different types of cancers, including oral, liver, rectal, and in the case of women, breast cancer (Boffetta et al., 2006). Similarly, the positive correlation between public wells and the increased likelihood of being diagnosed with cancer coincides with studies done by Aballay et al., (2012) and Liu-Mares et al., (2013) for their respective papers. The reason for this is due to the presence of arsenic, a carcinogen, in the waters of the wells. In these types of rural regions, the only treatment the water receives is being boiled, which prevents the spread of disease, but is useless in removing arsenic. It is this arsenic in drinking water that causes cancer (Smith et al., 1992). Ground water in areas of India has an arsenic concentration of

0.66μM (Sharma et al., 2013). This compared to the U.S. Environmental Protection Agency (EPA)'s arsenic rule of 0.133μM of arsenic shows that areas with public wells in India can have up to five times the limit set by the EPA. Making potable water more accessible in these rural areas is one possible policy consideration.

Of the non-significant variables, the most noteworthy one was smoking habit (SMOKING). Though positive, the fact that smoking was not significant could be attributed to the fact that the sample was not large enough. This could be due to the fact that in rural areas, among those that use tobacco, the majority prefer smokeless tobacco, and therefore the number of people that smoke would not be very large (Sinha, 2003). A larger sample size with more smokers could make the coefficient be significant, which is left for future studies.

With cancer being an ever prevalent problem in modern society, this paper sought to add to the sparse amount of literature linking family size to cancer diagnosis considering a data from India. Using a logit estimation model, the paper tried to identify how daily behaviors affect the risk of cancer diagnosis. The variable of interest being in a joint family, was negative and significant, suggesting that living in a joint family helps lower the likelihood of being diagnosed with cancer. This is in accordance to the few papers on this subject that show a lower risk of being diagnosed with cancer as birth order increases (Hemminki, 2003; Bevier, 2011). However, a further analysis showed that another factor playing to the negative coefficient could be the diminished likelihood of those in joint families to seek medical care and receive diagnosis. Due to joint families lowering cancer diagnosis in a positive and a negative way, possible policies that can eliminate the false negative can be making healthcare more accessible (as distance to healthcare centers contribute to healthcare expenditure), as well as more affordable in rural areas. Further improvements can be made by finding a way to separate the effects that living in a joint family has into two distinct variables. Though this study attempts to fill a gap currently in the literature, there is more still to be discovered.

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