The impact of HIV/AIDS on labour productivity in Kenya

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Summary

OBJECTIVES To estimate the impact of HIV/AIDS on individual labour productivity during disease progression.

METHODS We used a retrospective cohort design to study the productivity and attendance of tea estate workers who died or were medically retired because of AIDS-related causes between 1997 and 2002 in western Kenya. We compared daily output in kilograms of tea leaves plucked, use of paid and unpaid leave and assignment to less strenuous tasks by 54 workers who died or were medically retired because of AIDS to those of comparison workers, matched on time and tea field using longitudinal regression.

RESULTS HIV-positive workers plucked less tea in the 18 months preceding AIDS-related termination and used more leave in the 3 years before termination. After adjusting for age and environmental factors, cases plucked between 4.11 and 7.93 kg/day less in the last year and a half before termination. Cases used between 9.2 and 11.0 more sick leave days, between 6.4 and 8.3 more annual leave days, between 19.9 and 11.8 more casual leave days, and spent between 19.2 and 21.8 more days doing less strenuous tasks in the 2 years before termination than did comparison pluckers. Tea pluckers who terminated because of AIDS-related causes earned 16.0% less in their second year before termination and 17.7% less in the year before termination.

CONCLUSION These results provide empirical estimates of the impact of HIV/AIDS on labour productivity. As workers often bring unrecorded ‘helpers’, actual differences may be greater. Decreased attendance and output may put sick workers in jeopardy of losing their jobs and impose financial burdens on employers.

Keywords HIV, AIDS, Kenya, labour productivity, economics, private sector, regression analysis

Introduction

Few discussions of the potential economic impact of the global AIDS epidemic fail to observe that HIV/AIDS, unlike most other infectious diseases, strikes working-age adults during what should be their most productive working years. The mortality component of this loss is clear: lives lost to AIDS cannot contribute to economic growth. The morbidity component, however, has rarely been addressed. Although it is generally accepted that the morbidity associated with HIV/AIDS will lead workers to be less productive, and some estimates of AIDS-related increases in absenteeism have been made (Rosen et al. 2003), the pace and trajectory of the labour productivity decline is not well described. As a result, both firms and governments are hampered in their efforts to develop effective strategies for coping with the disease.

One reason for the dearth of empirical studies is that in most settings, neither the health nor the productivity of an individual worker can be directly observed (Strauss & Thomas 1998). An important exception to this rule is the commercial agriculture sector in developing countries. Workers on agricultural estates are often paid by the amount harvested each day, and they typically receive health care from on-site, company-owned medical facilities. The estates thus collect data on both the daily output and the health of each worker. Researchers have been taking advantage of such piecework settings to study the relationship between health and labour productivity more than 30 years (Foster 1967). Previous research conducted on agricultural estates has focused on three other diseases common to adults: schistosomiasis (Foster 1967; Fenwick & Figenschou 1972; Collins et al. 1976; Audibert 1986; Parker 1992); malaria (Brohult et al. 1981; Pehrson et al. 1984; Audibert 1986; Nur 1993) and onchocercal skin disease (Workneh et al. 1993; Kim et al. 1997); the impact of lymphatic filariasis (Ramu et al. 1996) on labour...
Impact of HIV/AIDS on productivity has been studied in non-agricultural piecework settings.

In this paper, we report the results of a study of the impact of HIV/AIDS on the labour productivity of agricultural estate workers in Kericho, Kenya. Our objective was to measure the magnitude and duration of productivity changes, thereby mapping the ‘natural history’ of productivity decline associated with AIDS. Using a retrospective cohort design, we linked data from company hospital records to records of daily productivity measures for workers at a tea plantation in Kericho District in Rift Valley Province, in the highlands of western Kenya.

Materials and methods

Study site

The study site is a large agroindustrial firm that both raises and processes tea, primarily for export. The company employs approximately 18 000 people. Virtually all employees live in family housing provided by the company. Tea pluckers are eligible for paid-sick leave and annual leave and receive a service gratuity upon reaching 10 years of service. They do not receive retirement, death or disability benefits.

The company maintains a central hospital and a system of dispensaries and clinics that provide full medical care to all workers and dependents free of charge. Voluntary counselling and testing for HIV is available at the hospital, though uptake is low. The hospital provides treatment for AIDS-related opportunistic infections but does not offer antiretroviral therapy.

Our study is restricted to the 10 000 workers whose primary job is plucking tea. Tea pluckers, who work 6 days a week, are paid for each kilogram of tea leaves they harvest each day. Pluckers are expected to harvest at least 33.2 kg of tea leaf per day. The union negotiated rate in 2003 was KSh 4.09/kg ($0.055). Pluckers are occasionally assigned to non-plucking tasks that are usually less strenuous than plucking, such as sweeping or weeding. For such ‘light duty’ days, the worker earns a flat daily wage rather than an amount based on output. The daily wage is equivalent to the wage for plucking 33.2 kg of tea.

Ethical review was provided by the authors’ institutions in the US and Kenya.

Selection of study subjects

Cases were tea pluckers who died at company health facilities of AIDS-related conditions or were medically retired because of HIV/AIDS-related morbidity between January 1997 and December 2002. To identify cases we collected all hospital records of natural cause deaths from 1997 to 2002 (n=601). As the hospital serves both employees and their families, of the 601 recorded deaths among employees and their dependents, only 199 were employees. Among these 199 employees, there were 71 whose primary job was tea plucking, and 47 of these suffered AIDS-related deaths. Two were removed from the final sample because they had significant amounts of missing data, and two others were removed because they were plucking far in excess of the amount that can be plucked by any one person in a single day, indicating that others had been engaged as ‘helpers’. This left 43 pluckers who had a primary cause of death listed as AIDS with a confirmatory HIV test (Unigold, Trinity Biotech, Wicklow, Ireland and Determine HIV-1/2/O, Abbott Laboratories, Abbott Park Illinois, IL, USA). Eleven pluckers who were retired for medical disability related to late-stage AIDS were also included, giving us 54 total cases. Medical retirement is usually carried out only after an employee has become very ill and is believed to be near death, so both deaths and retirements were included in the same analysis. We refer to our case deaths and medical retirements jointly as ‘AIDS-related terminations’.

Each case was matched to four comparison pluckers who were working in the same field as the case; we matched the days of observation of each comparison plucker to the same days of observation of the case to control for environmental variables that affect tea growth and labour productivity (e.g. plant age, weather conditions, etc.). Most comparison pluckers were still in the workforce at the time of data collection. While comparison pluckers could have been workers who died of other causes, in no case did this occur.

Data collection

The company records the number of kilograms of tea harvested per day by each plucker or, if the worker is not engaged in plucking on that day (either on leave, absent or assigned to light duty), the type of leave or job assignment. For each case, we collected daily productivity observations starting 4 years before the termination date of the case. If the case was not working 4 years before termination, we began with the case’s date of hire. We then collected daily productivity observations for each of the comparison pluckers for the same time period as the matched case. We obtained basic demographic data including sex, date of birth, date of hire, number of dependents and work site from human resources and medical facility records for each case and comparison plucker.
**Data analysis**

We assessed the impact of HIV/AIDS on four measures of productivity: work output (amount of tea leaf plucked) per day spent plucking; number of days of paid and unpaid leave; number of days of light duty and total earnings of the individual worker. To estimate the impact of HIV/AIDS on work output per day, we compared amounts of tea plucked per day by cases to amounts plucked by the comparison pluckers. For this analysis we excluded observations for days on which a case was absent or was assigned to non-plucking tasks. We limited our analysis to 3 years before termination, as not enough case pluckers had been working for more than 3 years to comprise an adequate sample in the fourth year.

To account for correlations among the daily observations for each individual, we modelled our data as a random effects regression model (Bryk & Raudenbush 1992; Longford 1993; Diggle et al. 1994; Goldstein 1995; Singer 1998; Naumova et al. 2001; Goldstein et al. 2002) for repeated observations. A random intercept and a random effect of time were also included to allow individual plucking trends to have different baseline levels and different curves. We regressed weekly mean plucking totals as a function of individual level covariates. Potential fixed effects included age, sex, years of experience, an indicator of the matched group, estate, season, and an indicator of disease status (terminated because of AIDS or was not terminated because of AIDS). We modelled time as a quadratic function to fit observed trends in plucking over time and included a term for an interaction between time and disease status.

To assess the impact of HIV/AIDS on changes in patterns of absenteeism, we estimated the increased number of days of each type of leave (sick leave, annual leave and absent without pay) in the 3 years prior to AIDS-related termination. We used the same productivity records that we used for the productivity analysis described above but limited the analysis to days when pluckers were on leave.

Using tobit regression we compared differences in individual use of each type of leave in the 3 years prior to the last day of observation, adjusted for age, sex and years of experience. We included dummy variables for each year of observation to indicate differences in leave taken by pluckers who went on to AIDS-related termination.

**Results**

**Study population**

The study population consisted of 271 tea pluckers, of whom 54 died (n = 43) or were retired on medical grounds because of HIV/AIDS (n = 11). In comparing demographic factors of cases and comparison pluckers (Table 1), the only nearly significant difference seen was that the comparison pluckers were slightly more experienced by about 1 year.

**Work output per day**

The median daily plucking total for all individuals was 36 kg (interquartile range 25.0–49.5). Unadjusted changes in mean productivity over time are shown in Figure 1. The means, which were averaged for 3-month periods and plotted over time, suggest relatively stable differences in plucking totals between cases and comparison pluckers up to a year and a half before AIDS-related termination, when the magnitude of the differences begins to increase.

Adjusted results are presented in Table 2. The final model included only age, a dummy variable for matched group, the variables for time, and a dummy variable to indicate pluckers who went on to AIDS-related termination. Sex and years of service were left out of the model.

<table>
<thead>
<tr>
<th>Table 1 Study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>------------------------------</td>
</tr>
<tr>
<td>n</td>
</tr>
<tr>
<td>Age (mean)*</td>
</tr>
<tr>
<td>Years of service (mean)*</td>
</tr>
<tr>
<td>Sex (proportion male)</td>
</tr>
</tbody>
</table>

* Dates computed as date on last day of observation.
as they were not found to be predictive of amounts of tea plucked. We also found no significant statistical interactions between age or sex and being an AIDS case.

In Table 2 we computed the expected differences at half-year intervals between cases and comparison pluckers after controlling for age and matched group using the modelled coefficients and changing values of time. Although there is a difference of 1.7 to +2.4 kg (4.1% to +5.8%) between cases and comparison pluckers in the period from 2 to 3 years before AIDS-related termination, this difference is not statistically significant. Starting at 1.5 years before termination, differences become statistically significant and much larger in magnitude.

### Light duty

Reports from tea estate managers indicated that when employees become sick, supervisors often shift them to ‘light duty’, for which they earn a flat amount equivalent to the wage for plucking 33.2 kg of tea. For healthy tea pluckers like those in our comparison group, who plucked an average of 42.8 kg/day, light duty represents a loss of income. For sick workers who cannot make the plucking quota, however, being shifted to light duty permits remaining in the workforce and continuing to be paid. Estate managers reported that because of increasing morbidity in the

### Table 2

<table>
<thead>
<tr>
<th>Years before termination</th>
<th>Difference†</th>
<th>Percentage difference‡</th>
<th>SE</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 years</td>
<td>−1.689</td>
<td>−4%</td>
<td>2.732</td>
<td>0.536</td>
</tr>
<tr>
<td>2.5 years</td>
<td>0.466</td>
<td>1%</td>
<td>2.224</td>
<td>0.834</td>
</tr>
<tr>
<td>2.0 years</td>
<td>2.400</td>
<td>6%</td>
<td>1.956</td>
<td>0.220</td>
</tr>
<tr>
<td>1.5 years</td>
<td>4.113</td>
<td>10%</td>
<td>1.871</td>
<td>0.028</td>
</tr>
<tr>
<td>1.0 years</td>
<td>5.605</td>
<td>13%</td>
<td>1.940</td>
<td>0.004</td>
</tr>
<tr>
<td>0.5 years</td>
<td>6.886</td>
<td>16%</td>
<td>2.191</td>
<td>0.002</td>
</tr>
<tr>
<td>Near termination</td>
<td>7.927</td>
<td>19%</td>
<td>2.684</td>
<td>0.003</td>
</tr>
</tbody>
</table>

* The final regression model included age, a dummy variable for matched group, the variables for time and a dummy variable to indicate pluckers who went on to an AIDS-related termination. † Difference in kilograms. ‡ Expressed as a per cent of the average kilograms plucked by comparison pluckers, 41.

### Table 3

<table>
<thead>
<tr>
<th>Type of absence</th>
<th>Unit</th>
<th>Comparison pluckers</th>
<th>Cases (period before AIDS-related termination)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2–3 years</td>
</tr>
<tr>
<td>Sick leave</td>
<td>No. of days per year</td>
<td>5.4</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>Percentage increase over comparison pluckers</td>
<td>63%</td>
<td>171%</td>
</tr>
<tr>
<td>Annual leave</td>
<td>No. of days per year</td>
<td>8.8</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Percentage increase over comparison pluckers</td>
<td>37%</td>
<td>73%</td>
</tr>
<tr>
<td>Unpaid leave</td>
<td>No. of days per year</td>
<td>21.4</td>
<td>46.6</td>
</tr>
<tr>
<td></td>
<td>Percentage increase over comparison pluckers</td>
<td>117%</td>
<td>93%</td>
</tr>
<tr>
<td>Total leave</td>
<td>No. of days per year</td>
<td>35.6</td>
<td>67.3</td>
</tr>
<tr>
<td></td>
<td>Percentage increase over comparison pluckers</td>
<td>89%</td>
<td>100%</td>
</tr>
</tbody>
</table>

* P-values are from tobit regression model comparing use of leave by case pluckers to comparison pluckers controlling for age, sex and years of experience.
workforce, they are supporting more workers on light duty than are needed for efficient operation.

We assessed the impact of HIV/AIDS on changes in patterns of light duty using the same method described above for leave. After controlling for age, sex and years of experience, we found no difference in time spent on light duty during the third year before AIDS-related termination, 19.2 days more in the second year before termination ($P = 0.016$) and 21.8 days more in the year before termination ($P = 0.041$) than comparison pluckers. These represented increases of 58% and 66% over comparison pluckers in the second and first years prior to AIDS-related termination, respectively.

Aggregate impact on annual output

The aggregate effect of the reduced attendance at work and more frequent shifts to light duty on the total number of days that a tea plucker with HIV/AIDS spends plucking tea is substantial. Figure 2 illustrates this impact.

The increase in non-plucking days shown in Figure 2 and the loss of productivity on days plucking shown in Figure 1 each represent a decline in the overall quantity of tea harvested by tea pluckers with HIV/AIDS. When the decreases associated with diminished productivity on days plucking, fewer days at work, and more days of light duty are added up, we find that, relative to other tea pluckers, pluckers who ultimately go on to an AIDS-related termination produce 30.5% less tea in their second to last year of life and 35.1% less tea in their last year.

Earnings

The combination of diminished output, more days of paid or unpaid leave, and more frequent light duty reduces the annual earnings of workers with HIV/AIDS. On days spent plucking, earnings vary directly with the quantity of tea plucked. Workers earn a flat wage for days spent on light duty or on paid (sick or annual) leave. They earn nothing on days of unpaid leave.

We found that tea pluckers who were terminated because of AIDS-related causes suffered an earnings loss of 16.0% in their second to last year before termination and 17.7% in their last year before termination. These differences are considerably smaller than the differences in annual tea leaf output noted above, reflecting the role of paid leave and light duty in smoothing workers’ incomes.

Discussion

The results presented here provide some of the first empirical estimates of the impact of HIV/AIDS-related morbidity on labour productivity. Of the tea plucker deaths and medical retirements that occurred at the study site between 1997 and 2002, 60% were attributable to AIDS. We found that as many as 3 years before an AIDS-related termination, farm workers with HIV/AIDS are absent from the job more often, cannot maintain their output when on the job, and are more often shifted to less strenuous (and less productive) duty. Relative to other tea pluckers, in the last 365 days on the job a tea plucker who eventually dies of an AIDS-related condition:

- Is absent from work 31 days more often (an increase of 87%);
- spends 22 days more on light duty (an increase of 66%);
- produces an average of 7.1 kg less tea leaf per plucking day (a decrease of 17%).

Each of these effects reduces the worker’s value to the employer. They also reduce his or her own earnings by almost 18%. In a setting in which the average daily wage of healthy workers is $2.37, a reduction of this size, to an average of $1.95/day, is likely to be detrimental to the welfare of everyone in the sick worker’s household.

The productivity changes among HIV-positive workers observed over the last 3 years of life show some distinct patterns. Productivity begins to deteriorate during the second year before termination, when the daily output of cases averages 92% of what we can think of as ‘full’ productivity (that of comparison pluckers). Starting at 1 year before termination, the productivity of the cases falls off sharply. Cases’ daily output averages 85% of comparison pluckers’ in the last year of life and drops to 81% in the final 3 months.
The gap between cases and comparison pluckers at the start of our data set, 3 years prior to termination, applies to attendance at work and output on the job. The existence of this gap may indicate that HIV/AIDS-related morbidity begins to affect worker performance well before the affected individuals would likely receive an AIDS diagnosis. Studies of disease progression in African cohorts suggest that most HIV-positive individuals progress from AIDS to death quite rapidly, in <1 year (Morgan et al. 2002). Our results could indicate that pre-AIDS morbidity affects the ability of infected workers over a substantially longer period of time than has previously been recognized. Alternatively, it may be that an unobserved variable, mostly likely behavioural, affects both HIV risk and work productivity independently.

The rapid fall-off of productivity we observe in the last year of life is consistent with other studies' findings of a rapid decline following an AIDS diagnosis. It is clear that the case subjects in our study become much sicker over the course of their last year. What is more surprising is that the absolute magnitude of the loss of output and attendance is not larger. The results suggest that even very sick workers make a great effort to appear at work and maintain their income levels for as long as they possibly can. We also believe that our results are very conservative estimates of the true loss of productivity caused by HIV/AIDS, as we explain in discussing study limitations below.

One difficulty in interpreting the results of this study is accounting for the behavioural coping strategies that tea pluckers and their supervisors adopt in the face of chronic illness. Shifting sick workers to day labour, which allows them to stay in the workforce and continue to be paid rather than being retired on medical grounds, is the most measurable of these strategies. Conversations with estate managers and supervisors led us to believe that pluckers are allowed to remain in the fields, rather than being shifted to light duty, on days when they feel capable of plucking, and given day labour on days when they are most incapacitated. If this is so, then our estimates of decreased daily output reflect only the days when employees are least affected by illness. In industries in which such shifts to less strenuous work are not possible, the time that we record as ‘light duty’ may be felt as absenteeism.

While our study has several limitations we believe that all of them tend to bias our results toward the null, making the findings conservative estimates of the impact of HIV/AIDS on labour productivity. First, we did not have disease status data on our comparison group. Overall HIV prevalence in the workforce of the Kericho tea estates is estimated as 15%, implying that a substantial number of our comparison workers could also be HIV-positive. As most were alive at the end of the period of observation, it is unlikely that they were near the end stage of disease during the observation period, but their productivity may well have been affected.

Secondly, on days when the yield of tea in the fields is high, pluckers are permitted (and even encouraged) to bring family members to pluck alongside them. These helpers contribute their output to the daily totals for the registered pluckers they are helping. The amount a helper contributes cannot be distinguished from the registered plucker’s total in our data set, nor can we determine which pluckers were accompanied by helpers on any given day. Although the presence of helpers in aggregate is largely a function of field conditions, anecdotal evidence from estate managers suggests that sick pluckers are more likely to bring helpers than healthy pluckers. For a sick plucker, the helper maintains daily income and hides the plucker’s illness from management. If there is systematically greater use of helpers by sick pluckers – and we believe that there is – this phenomenon will mask the true effect of disease progression on individual labour productivity as measured by daily output totals.

As this was a retrospective analysis using only existing, routinely collected medical data, we could not relate changes in productivity to disease progression except as a time interval before termination. Data on date of seroconversion and markers of disease progression, such as CD4 counts or clinical symptoms, would be needed to describe the full course of productivity loss caused by HIV/AIDS.

Finally, our estimates included only pluckers who died at a company medical facility or were retired on medical grounds. There is anecdotal evidence that many workers who are severely ill simply walk away from their jobs to return to their home villages, which are typically in other districts or villages. These employees did not enter into our analysis, as they had no diagnosis of HIV/AIDS. We do not know the direction of the bias that this practice might create. If only those HIV-positive pluckers who died in service are those employees who were well enough to work occasionally, our results will underestimate the impact of the disease on productivity. If, however, the HIV-positive pluckers who die in service are those who were too sick to travel home, the bias would likely be in the opposite direction.

Despite these limitations, the data presented here provide some of the first empirical evidence available on the impact of HIV/AIDS on labour productivity. Though the loss of productivity by the individual appears to be muted by the use of family labour, the aggregate impact of the disease over a worker’s last 2 years of life is substantial. The next challenge for researchers and employers is to determine the extent to which better care and treatment, including antiretroviral therapy, can offset these losses.
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Disclaimer

Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the US Army.

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