The Influence of Environmental and Household Factors on Mortality in North Orkney, 1851-1961

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In nonindustrial and industrializing agricultural societies, many aspects of personal well-being and quality of life are tied to a household's agricultural success. A successful farming enterprise can improve nutrition, longevity, and reproduction, while harvest failures can increase mortality and morbidity. For subsistence farmers, agricultural success is tied to both environmental and household contexts. Meteorological events and the availability and quality of land have effects on agricultural output. In addition, household contexts, including the age and sex composition of household members, determine both the level of production that needs to be met and the amount of labor available for farm work.

Studies in historical populations have shown that staple grain prices, and other indicators of short-term economic stress are important predictors of demographic patterns (Bengtsson and Saito 2000), including mortality (Bengtsson, Campbell, and Lee 2004), fertility (Tsuya et al. 2010), and migration (Breschi, Manfredini, and Fornasin 2011) outcomes. In general, high grain prices are associated with higher mortality, although the effects of elevated prices may vary by socioeconomic status (Lee, Campbell, and Bengtsson 2004). In Orkney, and elsewhere, household composition has been linked to mortality and health outcomes (Sparks 2007; Hagen, Barrett, and Price 2006; Campbell 1996). Households with unfavorable composition, meaning many dependent members relative to healthy, working age adults, experience higher levels of mortality. In addition, weather patterns are related to aggregate-level morality in Orkney (Parker, Jennings, and Wood 2011). For example, lower average minimum temperatures are predictive of higher mortality rates, while controlling for other factors (Table 1).

This study examines mortality timing at the individual level and includes environmental and household level variables that are important contributors to farming success, using data from the North Orkney Population History project. This project has collected and linked vital registers and census for North Orkney (1851-present), a group of islands in Northern Scotland. Until the 1950s, most island residents did not use tractors; therefore, this dataset offers a rare opportunity to study the relationships between traditional agriculture and demographic processes, including mortality. Individuals have been linked across vital records, so that they can be followed through life events, such as from birth to marriage and death.[1] These historical data add time depth to the study of the complex relationships between agriculturalists and the environment and may provide insight into these processes for both past and contemporary farming societies.

A variety of contextual information is available from this study area. In addition to demographic data from linked vital registers, household composition is available from decennial censuses. Valuation rolls, or records of the taxable value of land, are a good proxy for the amount and quality of land to which a household has access (Jennings 2010). These records also specify landowners, so it can be determined whether a given farm is owner-occupied or tenant-occupied. Crop prices come from records of Fiars prices, which were standardized exchange rates set each February by local leaders for the harvest year (Mitchison 1965). Fiars prices typically represent the average price of an agricultural product at local markets and sometimes were used to translate payments in kind into payments in cash. Prices of bere (a type of barley), oatmeal, malt, butter, oil, poultry, eggs, and kelp (a product made from burned seaweed) are included in the database. Meteorological data come from Stornoway Airport (approximately 100 miles southwest of Orkney) and is represented by monthly meteorological readings from 1873 until the end of our study period, 1961. While there is a modern weather station closer to Orkney today, it has only been in existence since 1914 and therefore would severely limit the range of

[1] The linkage rate is approximately 25 percent.

our analysis. Data from Stornoway and Wick, the closer station, have been compared from 1914 to 1961 and weather patterns are extremely similar, with Wick being a couple degrees Celsius colder on average.

Information about occupations is available in several sources. Occupations are commonly listed for men, and occasionally women, in census returns, vital records, and valuation rolls. For those individuals who do not have a listed occupation, the occupation of the head of household (typically a husband or father) is used. Farming and other agricultural work was the primary occupation of many island residents. Even individuals whose primary listed occupation was not farming (such as craftsmen or fishermen) probably participated in agriculture to some extent. For these analyses occupations will be coded to indicate whether the primary occupation is agricultural. This variable broadly represents the extent to which an individual (or their household) was engaged in agriculture. We expect that households directly involved in agriculture that work their own holdings (either rented or owned) would suffer fewer negative effects of variation in weather or food prices as they have more direct access to food resources when compared to those who work in agricultural day-labor, do not farm at all, or only farm as a side-employment.

We use Cox proportional hazards models to investigate the influence of environmental (land amount, mean monthly temperature and precipitation, and staple grain prices) and household (household composition, occupation, and land tenancy) factors on the time from birth until death, while controlling for other factors, including sex, age, and period. This individual-level approach to the study of the effects of economic stress on demographic outcomes has been applied successfully in many historical demographic contexts and represents an improvement upon earlier studies of aggregate-level mortality patterns in Orkney. In addition, the rich contextual information available from Orkney allows for analyses that account for both local and household-level factors that influence the timing of individual mortality. Special attention is paid to the relationship between weather and prices, during

model specification and selection as they are correlated. Yet, the use of these measures together helps establish whether price fluctuations are the result of weather conditions or external events, such as changes in trade policy, shortages outside of Orkney, conflict, or improvements in agricultural or transportation technology.

Tables and Figures

Table 1. Results of negative binomial regression of the yearly mortality rate (Parker, Jennings, and Wood 2011).

	Total Mortality
Average Min. Temp	-0.1206 (.05) *
Average Days Frost	-0.0702 (.04)
Average Month. Rain	0.0074 (.02)
Year	-0.1350 (.15)
Pop. Density	-0.1151 (.16)
Female/Sanday	0.0039 (.08)
Male/Sanday	-0.1381 (.11)
Female/Westray	0.1423 (.09)

(Standard error); * significant at $\alpha \leq 0.05$

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