

## Article

# Women's Trade-Offs between Fertility and Employment during Industrialisation

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**Abstract:** Modelling fertility decline in post-industrial populations in the context of life history theory has allowed us to better understand the environmental pressures that shape reduced family size. One such pressure, which has received relatively little attention from ecologists, is the movement of women into the labour market. Analyses of effects of employment on fertility in contemporary developing or post-demographic transition populations are limited by the widespread use of modern contraceptives: while uptake of these methods may be a mechanism by which reduced fertility is enacted, their use may obscure effects of employment on fertility. Here, we investigated the impact of women's employment on family size during a period of the movement of women into the workforce but prior to the use of modern contraceptives. We analysed the effects of women's employment on family size using census records from 1901 for a regional-level analysis of parishes in Scotland, and for 1851–1901 for an individual-level analysis of the Scottish city of Dundee. Women in employment had fewer children than those not in employment. Income was inversely related with family size, and this was independent of the effects of women's employment on family size. We suggest that female employment contributes to the evolution of smaller family sizes and that this takes place in the context of prevailing and emerging gender roles, and in interaction with opportunities for employment and wealth.

**Keywords:** fertility; demographic transition; female status; employment; life history theory; family size



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## 1. Introduction

Associations between women's employment and family size are situated in complex social, economic, and occupational contexts, and also influenced by the prevailing cultural norms around gender roles [1] and gender equity [2,3]. Life history theory provides a theoretical framework for the analysis of fertility, offering a link between the proximate conditions of an individual's social and physical environment, and the ultimate function of adaptive reproductive decision-making [4]. In life history theory, fertility (treated in this framework as current reproductive output or number of offspring) is guided by trade-offs in the allocation of somatic resources, including investment in raising offspring versus securing mating opportunities, and in current versus future offspring [5]. Fertility in contemporary non-industrial or developing societies is well explained by this theoretical framework, particularly when considered in the context of local ecologies [5].

There are multiple pathways by which the movement of women into paid employment may influence life history trade-offs and, consequently, fertility. Women's employment

may, for example, force a trade-off in the allocation of time for work versus parental care, allow women with preferences for lower fertility a greater say over their reproduction, or increase family income which, in turn, reduces family size [6–8]. Analyses of the effects of employment on fertility in developing or post-demographic transition populations, however, are confounded by use of modern contraceptives (i.e., hormonal and emergency contraception, male and female condoms). That is, effects of employment on fertility may be obscured by the widespread use of these methods, or there may be multiple pathways between employment status and use of modern contraception [9].

One factor to take into consideration is the reduction in the impact of environmental risk on mortality that is inherent in modernisation, which is likely to influence the magnitude of reproductive trade-offs. While there are trade-offs between number of children with investment in each child and child survival overall, for example, there is also considerable variation in the magnitude of the trade-off. This variation is likely due to wider environmental predictors of offspring success such as subsistence and mating systems, pathogen load, and predictability of resources [10]. In support of this, the trade-off between offspring number and survival across 27 Sub-Saharan populations was strongest in those populations with the greatest socioeconomic development, with such environments favouring fewer offspring [11]. Socioeconomic development, via a suite of environmental changes such as modernisation of health care, reduces the contribution of the extrinsic environment to child survival and success [11] and increases the importance of education to social and financial success [5,11], thereby increasing the strength of the relationship between parental investment and offspring success [12]. Modernisation, then, has been suggested to contribute to the reduced family sizes of post-demographic transition societies, with heavier investment in a smaller number of offspring increasing their future socioeconomic, if not reproductive, success [13]. One possibility, then, is that the movement of women into paid employment increases household income which, in turn, reduces family size.

While ecological research into the effects of women's employment on fertility is sparse, historiographical analyses of women's fertility during industrialisation and the first demographic transition show that women's paid employment was one factor in a complicated mesh of changes in marriage patterns, birth rate, mortality, family size, sexual attitudes and behaviour, and household composition [1,14]. Edwardian observers who noted fertility decline in women workers, matched with high infant mortality, supposed a causal direction in which women's work outside of the home resulted in increased rates of infant deaths and, therefore, smaller family sizes. This, however, was not supported by analyses of data from the 1911 census, which demonstrated that married women in England and Wales who were in paid employment were doing so because of low fertility (either because they had had fewer children or had suffered a larger number of infant losses; [1]). The association was strongest in those areas where there were greater opportunities for work outside of the home for women. This was often the case in areas where the manufacture of textiles was a dominant industry. Garrett [15] traced married couples across the 1851, 1861, 1871, and 1881 censuses in the town of Keighley in West Yorkshire. Here, 30–35% of workers were employed in the textile industry. She found that, where the husband's occupation allowed it, women tended to move from work into the role of 'housewife'. Where the husband's occupation was lower paid, as was the case for male mill workers, women were more likely to remain in work across time. It was in these couples where both worked in low-paid jobs that family size was lower. Therefore, the role of women's employment in fertility decline may be one of opportunity to work outside the home as a result of a smaller family size, rather than vice versa, and these smaller families and gendered social roles may become culturally normative in communities offering these affordances [1–3,15–18]. To date, however, research into women's employment and fertility prior to the advent of modern contraceptives has been limited to a small number of historiographic studies and there has been no attempt to determine whether women's employment influences fertility via consequences for household income.

Here, we sought to replicate and extend Garrett's analyses [1,16] within the theoretical framework of life history theory. That is, we investigated the impact of women's employment on family size during a period of the movement of women into the workforce but prior to the use of modern contraceptives. We tested predictions that (1) women who worked in paid employment would have smaller family sizes than those who were not employed, (2) women whose husbands were not in work or who were in low-paid occupations would be more likely to work themselves and would have fewer children, and (3) reduced fertility of women in paid employment occurred via an increase in household income. In Study 1, we analysed regional-level associations between the proportions of married women who were in employment and family sizes in parishes across Scotland in data extracted from the 1901 census. To supplement the regional-level data, we sought to replicate patterns from an alternative data source and at the level of individuals. Therefore, in Study 2, we modelled individual-level data from the decennial 1851–1901 censuses for the Scottish City of Dundee.

## 2. Study 1

### 2.1. Materials and Methods

#### 2.1.1. Integrated Census Microdata

We extracted census data for Scotland for 1901 from the 'Integrated Census Microdata' dataset (I-CeM), which is developed and managed by the Department of History at the University of Essex ([19], accessed on 15 March, 2018). I-CeM is an integrated collection of census microdata with 100% coverage of censuses for England and Wales (1851, 1861, and 1881 to 1911), and Scotland (1851–1901), thus facilitating longitudinal and cross-regional analyses. Here, we extracted data for the year 1901 as this corresponds with the peak of movement of women in Scotland into the industrial workforce, particularly the mill industries, which were a major employer of women [20]), which allows us to draw comparisons with the data described in Study 2.

#### 2.1.2. Women's Employment and Fertility

We extracted data on married women for all 879 civil parishes of Scotland in 1901. A civil parish was a unit of local government, established in 1845 in order to administer poor law and based upon the boundaries of pre-existing church parishes. Boundaries were realigned in 1891 so that all parishes fell in their entirety under a single county. For each woman returned in each Scottish civil parish, we extracted the number of male and female ever married and never married offspring living with her (F\_Off, M\_Off, F\_Offm, M\_Offm in the I-CeM dataset) and her occupation (OCC in the I-CeM dataset). We also counted the number of married women returned for each parish.

#### 2.1.3. Analysis

For each parish, we calculated the mean number of children of married women (i.e., sum of all children living with named women returned in the census/number of married women returned in the census), and percentage of married women returned in the census who reported an occupation (other than 'housewife' or 'wife of (husband's occupation)'). Percentage of married women in employment was log transformed in order to meet parameters of normality (post-transformation skewness =  $-1.11$ , kurtosis =  $5.95$ ).

We fit a simple linear regression model with mean number of children as the dependent variable and the log transformed percentage of married women in employment as the predictor variable.

### 2.2. Results

The mean number of children per each married woman across parishes was 2.34 (SD = 0.39). The mean percentage of married women in employment across parishes was 2.63 (SD = 3.53).

The linear regression model with log-transformed percentage of married women in employment as the predictor variable and family size as the dependent variable was significant ( $\text{Adj-R}^2 = 0.01$ ,  $F(1,727) = 10.72$ ,  $p = 0.001$ ), with a significant, moderate negative relationship between percentage of married women in employment and family size ( $\beta = -0.12$ ,  $p = 0.001$ ). That is, in parishes with a relatively higher proportion of married women in employment, there were relatively smaller family sizes.

### 3. Study 2

#### 3.1. Materials and Methods

##### 3.1.1. Subjects

We extracted 1630 entries from Dundee's censuses from 1851 to 1901. We identified records of the same woman who appeared in more than one census as those with the same name, living at the same address, and whose ages progressed as expected with census decade, and gave women a unique subject number. We included only women aged 40 years and under in analyses, to reduce the possibility of additional children who were not recorded in the census as they had left home. This reduced our sample to 815 records from 810 women (mean age = 31.18,  $SD = 6.07$ ).

To test the prediction that husband's occupational status would influence women's employment and family size, we analysed the subsample for whom an estimate of the woman's wage and that of her husband were available (including those for whom no occupation was listed, with a corresponding wage of 0; see 'Wages' below (Section 3.1.5)). This resulted in a subsample of 366 records from 365 women (mean age = 31.11 years,  $SD = 5.81$ ).

##### 3.1.2. Period

The peak of the jute industry was the mid to late 19th century, when more than 70% of workers were women [20]. Therefore, we extracted data from census records from 1851 to 1901.

##### 3.1.3. Streets

We used an electronic archive of historical photographs [21] to identify architecture classified as 'working-class' housing at the time. From these, we identified the addresses of the properties on historical ordinance survey and town plan maps [22]. This allowed us to identify streets located close to mills and with architecture typical of working-class households. We selected three streets at random: Blackscroft, Den's Brae, and Constitution Street.

##### 3.1.4. Records

We extracted the following information from the census records for each woman: address, name, age, occupation, number of children listed under her name, and husband's name and occupation if married. Census records were examined at Dundee Central Library, using microfiche readers.

##### 3.1.5. Wages

We coded the employment status of women and, if married, that of their husbands, in two ways. First, whether or not she was employed and whether or not her husband was employed. Second, we searched for data on wages for occupations listed in the census records for appropriate years. Wages tables were published for a subset of occupations [23]. We entered the median wage across employers (where wages varied across employers) in all cases.

##### 3.1.6. Analysis

To determine whether women who worked in paid employment had smaller family sizes than those who were not employed, we fit a set of restricted maximum likelihood linear mixed models (RMLLMMs) for the full dataset of records extracted from censuses

for the 810 women aged 40 and under. We compared RMLLMs with ‘employment status’ (employed, unemployed) as the fixed effect in the first set of models. ‘Subject’ was included as a random effect as is recommended for RMLLMs. We introduced additional random effects of ‘year’, ‘street’, and ‘age’ in turn and then the fixed effect(s) and compared models using analysis of variance.

To determine whether women whose husbands were out of work or in low-paid occupations had fewer children than women whose husbands worked in high-paid occupations, we fit RMLLMs for the subset of the 365 married couples for whom data on wages were available, with ‘couple employment status’ (both unemployed, husband only employed, both employed) as the fixed effect. Since there was only one woman who was employed while her husband was unemployed, this subject and category were excluded from analyses. We added ‘year’, ‘street’, ‘age’, and ‘couple income’ (wife’s wage + husband’s wage) as random effects. Inclusion of ‘couple income’ as a random effect allowed us to determine whether wealth increased the magnitude of the trade-off between offspring quantity and quality, thus resulting in fewer children. RMLLMs were conducted using the lme4 package of R version 3.1.2.

Finally, to determine whether husband’s occupation status was associated with women’s occupation status, we used chi-square cross-tabulation, using IBM SPSS version 22.

The number of children was positively skewed due to the large proportion of women with no children in the full sample and the subsample for whom wages were available, so we conducted Box–Cox transformations ( $\lambda = 0.58$  and  $0.69$ , respectively [24]).

### 3.2. Results

For full descriptive statistics, see Table 1.

**Table 1.** Descriptive statistics for (a) the full sample of women aged 40 and under and (b) the subsample of married couples for whom wages were available. Statistics are provided for n counts and means (with standard deviations) for continuous data.

| (a)                |                     | All Women<br>(n = 815) | Unemployed<br>(n = 510) | Employed<br>(n = 305) |
|--------------------|---------------------|------------------------|-------------------------|-----------------------|
| Age                |                     | 31.18 (6.08)           | 31.48 (5.78)            | 30.68 (6.52)          |
| Number of children |                     | 1.98 (1.76)            | 2.51 (1.76)             | 1.09 (1.36)           |
| Marital status     | Unmarried           | 114                    | 5                       | 109                   |
|                    | Married or widowed  | 701                    | 506                     | 195                   |
| Year               | 1851                | 129                    | 89                      | 40                    |
|                    | 1861                | 153                    | 124                     | 29                    |
|                    | 1871                | 137                    | 97                      | 40                    |
|                    | 1881                | 123                    | 53                      | 70                    |
|                    | 1891                | 136                    | 67                      | 69                    |
|                    | 1901                | 815                    | 80                      | 57                    |
| Street             | Constitution Street | 97                     | 73                      | 24                    |
|                    | Blackscroft Road    | 521                    | 313                     | 208                   |
|                    | Den’s Brae          | 197                    | 124                     | 73                    |

**Table 1.** *Cont.*

| (b)                     |                        | All Women<br>(n = 366) | Both<br>Unemployed<br>(n = 24) | Only Husband<br>Employed<br>(n = 274) | Both<br>Employed<br>(n = 68) |
|-------------------------|------------------------|------------------------|--------------------------------|---------------------------------------|------------------------------|
| Age                     |                        | 31.11 (5.82)           | 31.33 (6.05)                   | 31.44 (5.69)                          | 29.69 (6.1)                  |
| Number of children      |                        | 2.32 (1.75)            | 2.04 (1.46)                    | 2.61 (1.79)                           | 1.28 (1.21)                  |
| Couple wage (shillings) |                        | 18.82 (10.37)          | 0                              | 18.63 (9.4)                           | 26.23 (6.53)                 |
| Year                    | 1851                   | 60                     | 7                              | 43                                    | 10                           |
|                         | 1861                   | 72                     | 4                              | 65                                    | 3                            |
|                         | 1871                   | 67                     | 3                              | 61                                    | 3                            |
|                         | 1881                   | 49                     | 2                              | 29                                    | 18                           |
|                         | 1891                   | 53                     | 2                              | 35                                    | 16                           |
|                         | 1901                   | 65                     | 6                              | 41                                    | 18                           |
| Street                  | Constitution<br>Street | 42                     | 2                              | 32                                    | 8                            |
|                         | Blackness<br>Road      | 231                    | 16                             | 171                                   | 44                           |
|                         | Den's Brae             | 93                     | 6                              | 71                                    | 16                           |

#### Number of Children

Inclusion of 'employment status' significantly improved the model fit (model before inclusion (df(1,814)): AIC = 2418.4, BIC = 2437.2, log likelihood = −1205.2; model after inclusion: AIC = 2270.6, BIC = 2294.1, log likelihood = −1130.3;  $p < 0.0001$ ). Unemployed women had more children (mean = 2.51 (1.76)) than employed women (mean = 1.09 (1.36)), and post hoc analyses revealed that this difference was significant ( $t(2,813) = 13.05$ ,  $p < 0.0001$ ). For full model results, see Table 2.

**Table 2.** Explanatory power and significance of random and fixed effects in linear mixed models. Coefficients for models with outliers removed in parentheses.

|                    | Subject | Year | Street | Age | Employment | Model | AIC    | BIC    | Log-Likelihood | Test    | <i>p</i> |
|--------------------|---------|------|--------|-----|------------|-------|--------|--------|----------------|---------|----------|
| Number of children | X       |      |        |     |            | 1     | 2487.6 | 2501.7 | −1240.8        |         |          |
|                    | X       | X    |        |     |            | 2     | 2489.6 | 2508.4 | −1240.8        | 1 vs. 2 | 1        |
|                    | X       |      | X      |     |            | 3     | 2489.5 | 2508.3 | −1240.7        | 1 vs. 3 | 0.6848   |
|                    | X       |      |        | X   |            | 4     | 2418.4 | 2437.2 | −1205.2        | 1 vs. 4 | <0.0001  |
|                    | X       |      |        | X   | X          | 5     | 2270.6 | 2294.1 | −1130.3        | 4 vs. 5 | <0.0001  |

For the subsample of married couples for whom wages were known, inclusion of 'couple income' significantly improved the model fit (model before inclusion (df(1,365)): AIC = 1143.7, BIC = 1159.3, log likelihood = −567.83; model after inclusion: AIC = 1139.9, BIC = 1159.4, log likelihood = −564.93;  $p = 0.0161$ ). Inclusion of 'couple employment status' further improved the model fit (model after inclusion: AIC = 1128.8, BIC = 1152.3, log likelihood = −558.43,  $p = 0.0003$ ). Post hoc analyses revealed a significant negative relationship between 'total wage' and 'number of children' ( $rs(366) = -0.18$ ,  $p < 0.0001$ ) such that wealthier couples had fewer children and couples in which both were unemployed had significantly more children than those in which both were employed ( $t(2,90) = 2.1$ ,  $p = 0.041$ ) and that those in which only the husband was employed had significantly more children than those in which both were employed ( $t(2,340) = 3.86$ ,  $p < 0.0001$ ). For full model results see Table 3.

**Table 3.** Explanatory power and significance of random and fixed effects in linear mixed models of the subsample of women for whom their own wage and that of their husband were known. Coefficients for models with outliers removed in parentheses.

|                    | Subject | Year | Street | Age | Couple Income | Employment Status of Couple | Model | AIC    | BIC    | LL      | Test    | <i>p</i> |
|--------------------|---------|------|--------|-----|---------------|-----------------------------|-------|--------|--------|---------|---------|----------|
| Number of children | X       |      |        |     |               |                             | 1     | 1188.1 | 1199.8 | −591.06 |         |          |
|                    | X       | X    |        |     |               |                             | 2     | 1190.1 | 1205.7 | −591.06 | 1 vs. 2 | 1        |
|                    | X       |      | X      |     |               |                             | 3     | 1190.1 | 1205.7 | −591.06 | 1 vs. 3 | 1        |
|                    | X       |      |        | X   |               |                             | 4     | 1143.7 | 1159.3 | −567.83 | 1 vs. 4 | <0.0001  |
|                    | X       |      |        | X   | X             |                             | 5     | 1139.9 | 1159.4 | −564.93 | 4 vs. 5 | 0.0161   |
|                    | X       |      |        | X   | X             | X                           | 6     | 1128.8 | 1152.3 | −558.43 | 5 vs. 6 | 0.0003   |
|                    | X       |      |        | X   | X             | X                           | 7     | 1129.1 | 1156.4 | −557.56 | 6 vs. 7 | 0.1886   |

Chi-square cross-tabulation revealed a significant association between the occupational status of husbands and wives (Fisher’s exact test  $p = 0.012$ ). There were fewer women who did not work and whose husbands worked than was expected (274 vs. 279), more women who worked and whose husbands worked than was expected (68 vs. 64), and more women who were unemployed whose husbands were also unemployed than was expected (24 vs. 20).

#### 4. Discussion

Here, we found that women in paid employment had fewer children than those who were not in paid employed, both in aggregate data across regions and in individual-level data from a single city. We found that this was not due to a concomitant increase in household income, although there was an independent effect of household income (such that couples with a higher joint income had fewer children). We also found that women in Dundee whose husbands were employed were also more likely to be employed, and that women whose husbands were unemployed were more likely to be unemployed. Therefore, we replicated Garret’s findings [1,15,16] that women in paid employment have smaller family sizes but did not support her finding that women whose husbands were in employment were less likely to be employed themselves. We also added to previous findings by demonstrating that reduction in fertility amongst women in paid employment was not due to an increase in their household income.

We situated our study in the context of life history trade-offs. We suggested that the movement of women into paid employment may force a trade-off in the allocation of time for paid work versus parental care, allow women a greater say over their reproductive outcomes, or increase family income, which, in turn, reduces family size [8]. In our analysis of a sample undergoing demographic transition and industrialisation and prior to the use of modern contraceptives, we found that women’s employment did indeed predict smaller family size, at both regional and individual levels. While these findings are of value in themselves, adding to the relatively small body of existing work, what is perhaps more interesting are the finer-grained analyses of the ways in which women’s employment and wealth interacted during this time to predict family size.

In her analysis of couples returned in the decennial 1851–1881 censuses in the mill town of Keighley, Garrett [15] found that family size was lower in couples where both worked in low-paid jobs and that where the husband’s occupation allowed it, women tended to move from work into the role of housewife. Where the husband’s occupation was lower paid, women were more likely to remain at work across time. Our results from the mill town of Dundee do not support these patterns. We, instead, found that women were more likely to be employed if their husbands also were employed. It is possible that differences in the employment opportunities for men between Keighly and Dundee account

for this discrepancy. Opportunities for men were likely to have been lower in Dundee at the time (with working-class men known locally as ‘kettle-boilers’ due to their confinement to the home with little opportunity to work [20]). When men could work, as was the case in Keighly, this may have afforded their wives the opportunity to move into the role of housewife. If this were true, however, we might have expected far more cases where the woman was in employment and the husband was unemployed, yet we only found one such example. Perhaps we inadvertently selected streets that were unrepresentative of employment patterns in the city at the time. Indeed, the lack of cases in which the wife was the sole wage earner may have skewed our findings. We also cannot attribute our results to age (e.g., with both members of older couples being unemployed), or to differences in the employment opportunities of couples living in the different streets we sampled, as we limited our sample to women under 40 years old and included age and street as random effects in analyses. Perhaps there were other factors that underpinned the employment status of couples rather than individuals that we have failed to measure here, such as health. Alternatively, the differences between Garrett’s [15] findings and our own may stem from differences in methodology. She traced couples across decades, whereas we simply included individual women at a single time point. Therefore, her results would have been sensitive to changes in couple status over time, whereas ours may have picked up broader, population-level differences.

We predicted that wealth would be inversely related with family size. In our sample of women in Dundee, we found a significant negative relationship between the joint income of husbands and wives and family size: wealthier families had fewer children. This supports, for example, Lawson et al. [11] and Gibson and Sear [12], who argue that socioeconomic development, via a suite of environmental changes such as the modernisation of health care, reduces the contribution of the extrinsic environment to child survival and success and increases the importance of education to social and financial success, thereby increasing the strength of the relationship between parental investment and offspring success. While our results support this effect, they also demonstrate that the effect of women’s employment on fertility was not due simply to an increase in total household income. While we did find that wealthier families had fewer children, the effect of women’s employment was independent of this.

The limitations of census data as a research resource have been written about in detail elsewhere [1,15] and include, for example, lack of accuracy in the reporting of occupation and representing an incomplete snapshot of the population particularly in capturing women’s work. As such, the accuracy of our data was dependent on a number of factors that were out of our control, including the accuracy of the reporting of information by residents to the census-takers, and the accuracy and handwriting of the census takers. Furthermore, in both studies, our measure of number of children only included children living in the home, so it did not take into account those who had left or died. Although we attempted to reduce this issue in Study 2 by analysing data only from women aged under 40, it is still likely that our estimates of family size are conservative. The data also did not allow us to test the alternative mechanisms that link women’s employment to fertility, for example via trade-offs in the allocation of time for work versus parental care or by allowing women with preferences for lower fertility a greater say over their reproduction. While our data cannot tell us which, if either, of these explains our results, there may be clues in the historical context. Dundee at the time suffered from an extremely high infant mortality rate (174 per 1000 population [20]). This has been attributed to a combination of over-crowding, poverty, and the difficulties working mothers faced in feeding infants [20]. While we do not know whether infant mortality was higher for employed than unemployed women, the question remains whether reduced fertility amongst employed women was due to fewer births or more infant deaths. Future work will make use of genealogy databases, which contain historical birth and death records, in order to determine the mortality rate of infants of employed and unemployed women.

## 5. Conclusions

In conclusion, we present evidence from regional- and individual-level data in support of women's employment co-occurring with reduced fertility, independently of the uptake of modern contraceptives. We argue that the movement of women into the labour market contributes, alongside inter-related changes to household structure, socially enforced gender roles, and modernisation, to demographic transition. We also show that the reduced family size of employed women occurred independently of any contribution of women's income to household wealth, in a sample of women from Dundee during industrialisation. We argue that life history theory could be used as a framework to organise and generate predictions about fertility in contemporary societies, which are experiencing the social and cultural complexity of shifting gender roles and contraceptive practices.

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**Data Availability Statement:** Data are available on request from the authors.

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