



Factor Associated with Children Ever Born among Married Women in Ethiopia: Evidence from the 2016 Ethiopian Demographic and Health Survey Data

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ABSTRACT

Background: Children ever born are one of the main components that decide the population size, structure, and composition over time of any country. The average number of children born ever per woman in Ethiopia was 4.6 in 2016, which is higher than the average number of children ever born per woman in the world. This study aimed to estimate the magnitude and identify associated factors of children ever born for the country at large.

Method: Ethiopian Demography and Health Survey of 2016 data were accessed and used for the analysis. A total of 9602 married women were included in the analysis. Poisson and Negative Binomial models were used to identify determinant factors associated with the number of children ever born in Ethiopia.

Results: A total of 9,602 women were included in this study. About 90.6% of women have born at least one child, while the remaining 9.4% of women have never been born to a child in their lifetime. In addition, the overall mean number of children ever born per woman was 3.79 (95%CI: 3.74, 3.85). Rich wealth index (IRR=0.794; 95% CI: 0.685, 0.920), secondary and above education level of women (IRR=0.601; 95% CI: 0.569, 0.634), secondary and above education level of husbands' (IRR=0.917; 95% CI: 0.880, 0.955), used current contraceptive methods (IRR=0.973, 95% CI: 0.948, 0.998), employed women (IRR=0.894, 95% CI: 0.840, 0.951) and late married women (IRR=0.853, 95% CI: 0.833, 0.874) associated with the lower number of children ever born. Large family (IRR=2.229; 95% CI: 2.167, 2.293), rural residence (IRR=1.062; 95% CI: 1.021, 1.104), lost at least one child (IRR=1.637; 95% CI: 1.602, 1.673), and exposed to mass media (IRR=1.032; 95% CI: 1.005, 1.060) associated with a higher number children ever born. Moreover, women living in the Afar, Amhara, Gambella and Dire Dawa regions had a smaller number of children ever born compared to the Tigray regions.

Conclusion: The number of children ever born is high in Ethiopia. Therefore, concerned governmental organizations improve awareness to the community on the risk of early marriage, encourage education, expand mass media and pay special attention to poor and rural women. Meanwhile, policies need to be implemented to encourage contraceptive use and breastfeeding practices among married women.

Keywords: Children ever born; Married women; Sickle-cell disease

Abbreviations: CSA: Central Statistics Agency; CI: Confidence Interval; DF: Degree of Freedom (df); EDHS: Ethiopian Demographic and Health Survey; IRR: Incidence Rate Ratio; SNNP: South Nations Nationalities and Peoples of Ethiopia; LRT: likelihood Ratio Test; NB: Negative Binomial; DIC: Deviance Information Criteria; AIC: Akaike's Information Criterion; BIC: Bayesian's Information Criterion; EPHI: Ethiopian Public Health Institute; EHNRI: Ethiopian Health and Nutrition Research Institute; NRERC: National Research Ethics Review Committee; CDC: Centers for Disease Control

INTRODUCTION

Children ever born are one of the main components that decide the population size, structure, and composition over time of any

country. The total number of children to be born per woman is not only a direct measure of the level of fertility but also an indication of the expected change in population in the world [1]. The trends

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of children ever born in most of the developed world at the end of the 1990s showed a significant decline of two children or less than the usual six children per woman. Despite the declining number of children ever born, the total number of children ever born in sub-Saharan Africa is still high. The total numbers of children ever born have an average of five children per woman in sub-Saharan Africa, while countries such as Chad, Mali, Niger and Nigeria have more than six or seven children per woman. It is estimated that half of the world's population growth will be concentrated in only nine countries from 2017 to 2050, including Ethiopia [2-4]. Ethiopia is the second most populated country in Africa with a population of over 112 million in 2020, accounting for about 1.45% of the world's total population [5]. The average number of children born ever per woman in Ethiopia was 4.6 in 2015, which is higher than the average number of children ever born per woman in the world [6].

Not only for a country but for the welfare and health of the individual, family and community, the size of a family is of great significance. Increases in maternal and pediatric diseases and/or mortality can result from high fertility coupled with high population growth. In addition, poverty, drought and famine, illiteracy, poor infrastructure and low agricultural and industrial productivity have compounded the impact of overpopulation [7,8].

Different countries have carried out different studies [9-19] to determine the determinant factor of children ever born. The above studies explored the determinants of children ever born by using the binary logistic model. Although the total number of children ever born is undercounted by binary logistic regression since multiple fertility is collapsed into a single unit to satisfy binary logistic regression requirements, it provides ample information to analyze the multiple birth patterns. The count regression model is the preferred model in this study. The outcome variable is the number of children ever born per woman, and the primary objective is to see how this count changes as the explanatory variable increase. The most popular model used for analyzing the count data is the Poisson regression model. The mean and variance must be equal are one of the assumptions of Poisson regression, but most of the data have a greater variance or over dispersion [20]. The negative binomial regression model is more versatile than that of the Poisson model and is often used to analyze over-dispersion count data [20-22]. Therefore, this study aimed to estimate the magnitude and identify associated factors of children ever born for the country at large.

METHODS

Source of data

Ethiopian Demography and Health Survey (EDHS) of 2016 data were accessed and used for the analysis. The survey was cross-sectional population-based. For the surveys, the 2016 EDHS sample was stratified and selected in two stages. In the first stage, a total of 645 clusters (202 in urban and 443 in rural) were randomly selected proportional to the household size from the sampling strata and in the second stage, 28 households per cluster were selected using systematic random sampling. Children aged (0-59 months), women aged 15-49 years, and men aged 15-59 years old were the target population of the survey. Detailed information was collected on the background characteristic of the respondents, fertility, marriage, fertility preference, awareness and use of family planning methods, child feeding practices, nutritional status of

women and children, adult and childhood mortality, awareness and attitudes regarding HIV/AIDS, female genital mutilation, domestic violence, and height and weight of women and children aged 0-5 years from 16,688 households, and 15,683 female and 12,688 male respondents.

Outcome variable

The outcome variable for this study was the number of children ever born per woman.

Explanatory variable

Potential predictors of the number of children ever born are residence, wealth index, education level of women, education level of husband, occupation of women, region, age at first marriage, contraceptive use, family size, access to mass media and child death experience [9-19].

Data processing and analysis

The data were cleaned and analyzed using R version 3.5.3 statistical software. Descriptive statistics were done to describe the data using frequencies and percentages. Count regression models were developed to model data with integer outcome variables. The most popular model for count data is the Poisson model, which is based on the property that the mean and variance of the dependent variable are assumed to be equal [20]. However, this is not always the case, as the variance sometimes exceeds the mean. This is referred to as over dispersion [23]. Over dispersion can be modeled using the Negative Binomial (NB) regression model, but more models accounting for over dispersion exist. The negative binomial regression model assumes a gamma distribution for the Poisson mean with variation over the subjects [23,24].

Poisson regression model

Poisson regression is commonly used for the analysis of count data [25,26], but requires that mean and variance be equal on the basis of a given set of covariate values [26]. Poisson regression may not work well when this requirement is not met, a condition known as over dispersion [27,28]. The probability density function for Y is given by,

$$p(Y = y_i / \mu_i) = \frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!} \quad y_i = 0, 1, 2, \dots, \quad \mu_i > 0, i = 0, 1, 2, \dots \quad (1.1)$$

Where, y_i is the number of children ever born the i^{th} mother in a given time with a mean parameter μ_i . The mean and variance of Poisson distribution is given as,

$$E(y_i) = Var(y_i) = \mu_i$$

Negative Binomial Regression Model (NB)

The Negative Binomial (NB) regression model can be used when the Poisson regression model is not appropriate because of over-dispersion [20-22]. In addition, the dispersion parameter is determined by the negative binomial regression model, which also separately determines the mean and variance. However, the dispersion parameter that links the variance and the mean set at one is used in the Poisson regression model. We understand here that variance is the only difference between negative binomial and Poisson regression models, while synonyms can be given to the model coefficients across the two defined models. If there is variability in the variance, it is clear that the two models' standard errors are also different. If there is an over dispersion on the response variable, then the variance becomes larger, which internally

indicates that even though it is more proper, the normal errors are often large [20-22]. In the negative binomial regression model, the addition of dispersion parameters has the advantage of equipping over dispersion by controlling unobserved heterogeneity in count data. The problem of over-dispersion occurs because of hidden heterogeneity in the data [29]. The probability mass function of NB model is given by:

$$P(y_i, \mu_i, \alpha) = \frac{\Gamma(y_i + \frac{1}{\alpha})}{y_i! \Gamma(\frac{1}{\alpha})} (1 + \alpha \mu_i)^{-\frac{1}{\alpha}} \left(1 + \frac{1}{\alpha \mu_i}\right)^{-y_i} \quad y_i \geq 0 \text{ and } \alpha > 0 \quad (3.2)$$

Where α is the over dispersion parameter and $\Gamma(\cdot)$ is the gamma function when α the Negative Binomial distribution is the same as Poisson distribution. The mean and variance are expressed as:

$$E(y_i) = \mu_i = \exp(x_i^T \beta), \text{Var}(y_i) = \mu_i (1 + \alpha \mu_i)$$

Assessing model adequacy and model comparisons

The Likelihood Ratio Test (LRT) was used to determine the fitness of two nested models. The candidate model has been compared using Deviance Information Criteria (DIC), Akaike's Information Criterion (AIC), and Bayesian's Information Criterion (BIC). The model with the minimum value of the information criterion was used as the final model of the analysis [30].

Ethics approval and consent to participate

This study is a secondary data analysis of the EDHS, which is publicly available, approval was sought from MEASURE DHS/ICF International and permission was granted for this use. The original DHS data were collected in conformity with international and national ethical guidelines. Ethical clearance was provided by the Ethiopian Public Health Institute (EPHI) (formerly the Ethiopian Health and Nutrition Research Institute (EHNRI) Review Board, the National Research Ethics Review Committee (NRERC) at the Ministry of Science and Technology, the Institutional Review Board of ICF International, and the United States Centers for Disease Control and Prevention (CDC). Written consent was obtained from mothers/caregivers and data were recorded anonymously at the time of data collection during the EDHS 2016.

RESULTS

Descriptive statistics of the number of children ever born per mothers

Based on data from 9,602 married women, indicates the frequency and percentage distribution of the number of children ever born in Ethiopia. About 90.6% of mothers born at least one child, while the remaining 9.4% of mothers never born a child in their lifetime. Further screening of the number of children ever born found that the variance (7.67) was higher than the mean (3.79), suggesting over-dispersion. This indicates that the data could be fitted better by a negative binomial model that takes account of over-dispersion (Table 1 and Figure 1).

Table 1: Frequency distribution of the number of children ever born per mothers

Number of children ever born	Frequency	Percentage (%)
0	907	9.4
1	1454	15.1
2	1408	14.7
3	1241	12.9

4	1077	11.2
5	952	9.9
6	778	8.1
7	699	7.3
8	476	5
9	303	3.2
10	307	3.2
Total	9602	100

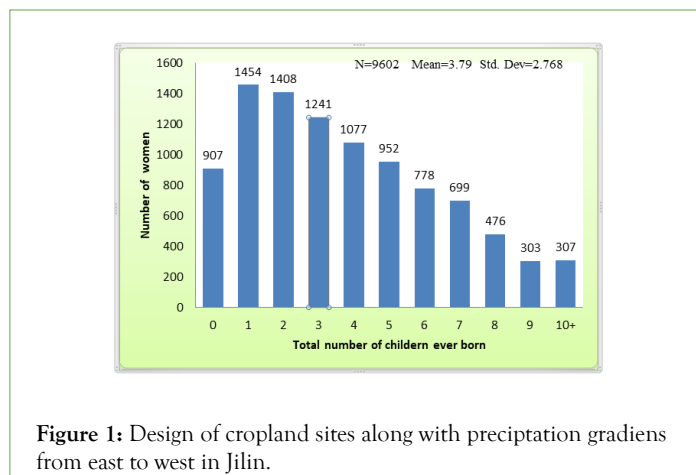


Figure 1: Design of cropland sites along with precipitation gradients from east to west in Jilin.

Magnitude of children ever born by socio-demographic characteristics of study participants

The highest mean number of children ever born was occurred in Somali (mean=4.77) and the lowest was in Addis Ababa (mean=1.99). The mean number of children ever born for uneducated husbands (mean=4.61) was two times higher than husbands with secondary and above education (mean=2.28). The expected number of children ever born in a rural area (mean=4.55) was higher than in urban (mean=2.50). Employed women have a lower mean number of children ever born (mean=3.59) as compared to housewives women (mean=3.89). The expected number of children ever born was higher for women with no education (mean=4.80). The lower mean number of children ever born (mean=1.78) was reported among households with 4 or lower members. The mean number of children ever born was highest (mean=4.25) among women less than 17 years old at first marriage and the expected number of children ever born was highest (mean=4.30) among the poor wealth index. The mean number of children ever born was also higher among households who had no access to media (mean=4.14) than those who had access to media (mean=3.25) (Table 2).

Table 2: Magnitude of children ever born by socio-demographic characteristics of study participants

Variables	Categories	Frequency (%)	Mean	Std. deviation
Region	Tigray	935 (9.74)	3.86	2.81
	Afar	858 (8.94)	3.77	3.02
	Amhara	1114(11.60)	3.73	2.68
	Oromia	1286(13.39)	4.23	2.79
	Somali	973(10.13)	4.77	3.05
	Benishangul-gumuz	791(8.24)	4.11	2.77
	SNNPR	1198(12.48)	4.27	2.71
	Gambela	686(7.14)	3.12	2.2
	Harari	568(5.92)	3.14	2.44
	Addis Ababa	625(6.51)	1.99	1.49
	Dire Dawa	568(5.92)	3.2	2.67

Residence	Urban	2369(24.67)	2.5	2.16
	Rural	7233(75.33)	4.22	2.81
Women's occupation	Housewife	6542(68.13)	3.89	2.79
	Employed	3060(31.87)	3.59	2.7
Have a dead child	No	7051(73.43)	2.95	2.32
	Yes	2551(26.57)	6.12	2.55
	No education	5625(58.58)	4.8	2.74
Women's education	Primary	2621(27.30)	2.71	2.29
	Secondary	1356(14.12)	1.73	1.52
	Less or equal to 4	3519(36.65)	1.78	1.68
Household size	Greater than 4	6083(63.35)	4.96	2.6
	Poor	4354(45.34)	4.3	2.85
Wealth index	Middle	1342(13.98)	4.08	2.72
	Rich	3906(40.68)	3.13	2.55
	No	6715(69.93)	4.04	2.89
Contraceptive use	No	2887(30.07)	3.22	2.35
	Yes	2887(30.07)	3.22	2.35
Age at first marriage	< 17 years	6231(64.89)	4.25	2.79
	>17 years	3371(35.11)	2.96	2.52
	No education	4454(46.39)	4.61	2.84
Husband's education	Primary	3002(31.26)	3.66	2.62
	Secondary	2146(22.35)	2.28	2.04
Access to mass media	No	5,848(60.90)	4.14	2.81
	Yes	3,754(39.10)	3.25	2.61

Test of over dispersion and model selection criteria

The formal test of over dispersion in Poisson and NB regression, $H_0: \alpha = 0$ (no over dispersion in the dataset) $H_1: \alpha > 0$ (there is over dispersion in the dataset). Since, the likelihood ratio statistic $(2[-18558.16 - (-18634.55)] = 152.78)$ with P -value < 0.001 , indicating that the null hypothesis is rejected and there is over-dispersion in the data set which favors the NB regression model. Furthermore, the negative binomial regression model has the smallest AIC, BIC, and Deviance statistics. This shows that the negative binomial model is a better fit for data as compared to the Poisson regression models (Table 3).

Table 3: Test of over Dispersion and Model Selection Criteria.

Criteria	Poisson	Negative Binomial
Deviance	37269.1	37116.32
AIC	37297.1	37164.31
BIC	37397.48	37336.39
Likelihood ratio (LR) test	Value=152.78 d.f=1 p-value < 0.001	

Factors associated with the number of children ever born in Ethiopia

To identify the factors associated with the number of children ever born, the negative binomial regression model was applied. The result of the negative binomial regression model revealed that residence, wealth index, women education status, husband's education status, women occupation, age at first marriage, contraceptive users, family size, mass media exposure and experience of child death were significantly associated with the number of children ever born. The estimated number of children ever born in the Afar region was 0.852 (IRR=0.852; 95% CI: 0.804, 0.902) times lower compared to the Tigray region. The estimated number of children ever born was 0.898 (IRR=0.898; 95% CI: 0.844, 0.955) times lower in the Gambela region than in the Tigray region. Compared to the small family size, the estimated number of children ever born among larger family sizes was 2.229 (IRR=2.229; 95% CI: 2.167, 2.293)

times higher. The estimated number of children ever born in rural areas was 1.062 (IRR=1.062; 95% CI: 1.021, 1.104) times higher than in urban areas. For women who had lost at least one child, the estimated number of children ever born was 1.637 times higher (IRR=1.637; 95% CI: 1.602, 1.673) compared to women who had never had a child death experience. Compared to poor women, the estimated number of children ever born to rich women was 0.794 (IRR=0.794; 95% CI: 0.685, 0.920) times lower. Relative to women who did not attend any formal education, women who attended primary education were 0.759 (IRR=0.759; 95% CI: 0.737, 0.781) times lower estimated number of children ever born. Women attending secondary and higher education are 0.601 (IRR=0.601; 95% CI: 0.569, 0.634) times lower estimated number of children ever born relative to women not attending any formal education. Compared to husbands who have no education, the estimated number of children ever born among husbands attending primary education was reduced by 6.7 percent (IRR=0.932; 95% CI: 0.908, 0.956). Compared to husbands who have no education, the estimated number of children ever born among husbands attending secondary and higher education decreased by 8.3 percent (IRR=0.915; 95% CI: 0.878, 0.953) compared to husbands who have no education. Women who were married at the age of above 17 years were 0.853 (IRR=0.853, 95% CI: 0.833, 0.874) times lower estimated number of children ever born than women who were married at the age of 17 years and below. The estimated number of children ever born of women belongs to households who had access to mass media was 1.032 (IRR=1.032; 95% CI: 1.005, 1.060) time higher than that of households who had no mass media (Table 4).

Table 4: Parameter estimates using Negative Binomial model.

Variable Region	IRR	95% CI of IRR	P-value
Tigray (ref)	1.0	1.0, 1.0	0.001
Afar	0.852	0.804, 0.902	0.001
Amhara	0.9	0.860, 0.942	0.001
Oromia	0.982	0.935, 1.031	0.469
Somali	1.056	0.999, 1.117	0.052
Benishangul-gumuz	0.998	0.948, 1.053	0.986
SNNPR	1.01	0.959, 1.064	0.703
Gambela	0.898	0.844, 0.955	0.001
Harari	0.955	0.895, 1.019	0.168
Addis Ababa	0.93	0.865, 1.003	0.051
Dire Dawa	0.929	0.871, 0.992	0.028
Residence	0	0	0
Urban (ref)	0	0	0
Rural	1.062	1.021, 1.104	0.002
Mother occupation	0	0	0
House wife (ref)	0	0	0
Employed	0.894	0.840, 0.951	0.004
Have a dead child	0	0	0
No (ref)	0	0	0
Yes	1.637	1.602, 1.673	0.001
Mother's education	0	0	0
No education (ref)	0	0	0
Primary	0.759	0.737, 0.781	0.001

Secondary and above	0.601	0.569, 0.634	0.001
Family size	0	0	0
Less or equal to 4 (ref)	0	0	0
Greater than 4	2.229	2.167, 2.293	0.001
Wealth index	0	0	0
Poor (ref)	0	0	0
Middle	0.995	0.963, 1.027	0.744
Rich	0.794	0.685, 0.920	0.002
Contraceptive use	0	0	0
No (ref)	0	0	0
Yes	0.973	0.948, 0.998	0.034
Age at first Marriage in years	0	0	0
<=17 years (ref)	0	0	0
>17 years	0.853	0.833, 0.874	0.001
Husband's education	0	0	0
No education (ref)	0	0	0
Primary	0.932	0.908, 0.956	0.001
Secondary and above	0.915	0.878, 0.953	0.001
Access to Mass media	0	0	0
No (ref)	0	0	0
Yes	1.032	1.005, 1.060	0.019

Note: ref: reference category of the categorical variable.

DISCUSSION

The objective of this study was to identify socioeconomic and demographic determinants of the number of children ever born in Ethiopia. A total of 9,602 women were included in this study. About 90.6% of women have born at least one child, while the remaining 9.4% of women have never been born to a child in their lifetime. In addition, the overall mean number of children ever born per woman was 3.79 (95% CI; 3.74, 3.85). The negative binomial model had the lower Deviance, AIC and BIC value compared to the Poisson model. The negative binomial model was the best model for the number of children ever born. Several studies reported similar results that the negative binomial model was the best model for over dispersed data [1,26,31,32].

According to the result, parental education level is an important socio-economic predictor of the number of children ever born, which means that the number of children ever born decreases with an increase in the level of parental education. This result is in line with the previous studies, when there is a higher level of maternal and husband education results in a lower number of children ever born [9,11,17,33-36]. The potential explanation may be that educated women have greater autonomy to make decisions to discourage early marriage and childbirth. Moreover, educated women and husbands are more likely to spend many years in school, because when they get married they can increase their age, which may help to decrease the number of children they can have.

As a result, there have been geographical regional variations in

the number of children ever born in the country. The number of children ever born is lowest in Addis Ababa, while the number of children ever born is high in other regions, such as Somali, Oromiya, and SNNP. This result is consistent with [36,37]. This may be due to the different distribution access to family planning services and the provision of facilities for education and health.

Compared to rich households, the estimated number of children ever born in poor households was higher. This is in line with other studies [35,36,38]. This may mean that parents use children as a source of income in poor households. Compared to urban areas, women in rural areas have a higher estimated number of children ever born. This is in line with a study conducted in Ethiopia [9,11], Nigeria [35] and Bangladesh [33], which found that in rural areas the number of children ever born was higher. This could mean that a rural woman has a negative feeling about a smaller number of children and little access to family planning.

Women who are married at an early age tend to a higher number of children ever born. This finding was similar to other studies [11,17,34,39], which find out that the number of children ever born was low as the age of marriage increased. The explanation behind this can be due to the fact that women who got married at their early age are likely to have many children for many years to reach their menopause age. Furthermore, women married at an early age may either leave school or not attend school, as discussed above, which is indirectly related to education. Compared to women who used contraception, women who had never used contraceptives had higher estimated numbers of children ever born. This makes it clear that the method of contraception seeks to limit the number of children. This finding was similar to studies conducted in Ethiopia [9]. However, this finding was different from studies conducted in Ethiopia [17], Bangladesh [33], and Nigeria [35]. This difference may be due to the disparity in time and design of the studies conducted.

The estimated number of children ever born was higher for women who had lost at least one child compared to women who had never had a child-death experience. This finding is in agreement with other studies [12,17]. This may be the fact that women with a history of child death want to replace their child, even though they are afraid of facing the same issue.

Women's working status affects the number of children ever born. Compared to housewife women, women who were working had a lower estimated number of children ever born. This is in line with [11,33,34], where working women are correlated with fewer newborn children

As compared to women belonging to the lower family size, women with a higher family size had a higher number of children ever born, which is consistent with a study in Butajira, Southern Ethiopia [12]. This may be done because they have enough time for their children to provide treatment when a household member is high.

Strength and limitations of the study

The study used nationally representative DHS data collected from 2016. This helps to provide better representative data as all regions and administrative cities in the country were included. However, some variables are not used because of a significant number of missing attributes, such as age at first birth and sex preference. As a result of the convergence problem, the interaction term is not considered in this analysis.

CONCLUSION

The number of children ever born is high in Ethiopia. The negative binomial regression model showed that the number of children ever born was significantly correlated with residence, wealth index, women education status, husband's education status, women occupation, age at first marriage, contraceptive use; family size, mass media exposure and child death experience. Therefore, concerned governmental organizations improve awareness to the community on the risk of early marriage, encourage education, expand mass media and pay special attention to poor and rural women. Meanwhile, policies need to be implemented to encourage contraceptive use and breastfeeding practices among married women. Furthermore, the community should be aware of the consequences of high fertility on the child and maternal health, household economy, human capital investment, and environmental degradation.

AVAILABILITY OF DATA AND MATERIALS

The data set was accessed from the Measure DHS website (<http://www.measuredhs.com>).

AUTHOR CONTRIBUTIONS

SM conducted the literature search, planned the study, carried out the data extraction, performed the data analysis and interpretation, and drafted the manuscript. SG revised the subsequent draft of the paper. Both authors read and approved the final manuscript.

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