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Biological living standards in North Korea as reflected in famine to post-famine trends in birthweight, 1998–2009

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ABSTRACT

This research investigates the trend in birthweight as an indicator of living conditions in early life inside North Korea, one of the most secluded nations in the world that experienced a great famine in the 1990s. Descriptive analysis based on data taken from officially released national nutrition survey reports suggests that prevalence of low birthweight (= below 2500 g) declined from 9.0% in the famine year of 1998–5.7% in the post-famine period of 2009. Mean birthweight improved from 2800 g in 1998–2940 g in 2002, although more recent surveys await implementation. Based on raw data comprising 2495 newborns measured at birth from 2000 to 2002 from a national nutrition survey conducted in 2002, neither contingency analysis nor error bar analysis showed statistically significant improvements during the observed periods. Regression analysis indicates that there is a significant positive relation between birthweight and birthyear, but the effect is negligibly small (0.0001 g). Raw data analysis of the 2002 survey further revealed that prevalence of low birthweight hovered at around 7% from 2000 to 2002. Overall, this prevalence of low birthweight was closer to the mean percentage for industrialized nations (6%) than that of developing nations (17%), although being expectedly much higher (that is, twice the rate) compared to its "twin" in South Korea (3.5%) at that time. Some technical, biological, and socio-economic biases affecting birthweight measurements in North Korea are discussed in a latter section of this paper.

Introduction

Despite dissolution of the Soviet Union resulting in the end of the Cold War in the 1990s, the Democratic People's Republic of Korea (DPRK), commonly known as North Korea, remains perhaps the last remnant of hardline communism in the world. Yet, the population was not immune to the geopolitical changes of the 1990s. In fact, living conditions noticeably deteriorated towards the end of the Cold War, as its closest ideological ally, the Soviet Union, no longer supplied vital import goods required to support the inefficient command economy in the DPRK. The economic crisis in turn resulted in a great famine, which was triggered by two floods in 1995 and 1996 as well as a drought in 1997.

Investigation of biosocial living standards in North Korea remains quite a challenge. Manipulated or not, not much data have been made public by the North Korean government, which officially issued its last Central Yearbook containing population data in the year 1963 (Corfield, 2013: 21). Consequently, the DPRK has been described as an "enigma", "mystery", or "terra incognita" (Shim, 2010: 13).

Facing a statistical void for most of the Cold War era, some studies have attempted to investigate biosocial living conditions in

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North Korea by surveying refugees. For instance, age at menarche among North Korean refugee women was found to be 16.0 years, as opposed to the United States, where it was shown to be 12.7 years among white Americans and 12.1 years among black Americans (Ku et al., 2006). Similarly, mean final heights of male and female North Korean refugees born in the 1980 s were found to be 1655.5 mm and 1555.8 mm, which are about 80 mm and 50 mm lower than those of their South Korean age peers (Pak et al., 2011).

As the DPRK joined the United Nations at the end of the Cold War, more biosocial data have been collected since membership not only grants benefits, including international development assistance and food aid, but also duties such as conducting population censuses or allowing in nutrition survey teams. In the first internationally acknowledged census of 2008, longevity was estimated at 2.7 centenarians per million persons in North Korea, corresponding to a rate already achieved in South Korea in 1925 (Schwekendiek, 2018). In analyzing raw data from various national nutrition surveys carried out with the assistance of various international agencies, North Korean preschool children aged 1–5 years were shown to lag behind their South Korean counterparts by some 60–70 mm in height, 3 kg in weight, and about 1 unit in body-mass index (Schwekendiek and Pak, 2009). Mid-upper arm circumference of North Korean women aged 20–39 years was on average 28 mm below that of South Koreans (Schwekendiek, 2013).

While all population studies on North Korea have investigated the effects of the environment on pre-school children and adults, there has been no study exploring living conditions around the time of birth. The primary aim of this study is to shed light on the biological standards of living in very early life by analyzing trends in birthweight among North Korean newborns.

Indeed, analyzing birthweight offers researchers a unique opportunity to gather “retrospective information” on the nutritional and developmental status of a child at birth (Frisancho, 1990: 40). Thus, birthweight can be understood as an indicator of biological living standards (Komlos and Baten, 1998). In technical terms, birthweight is defined as the initial weight of a live born baby measured within the first hour of life (United Nations Children’s Fund and World Health Organization, 2004: 4). Surprisingly, scant attention has been paid to birthweight as an indicator of biological living standards in North Korea. Indeed, birthweight is the “most widely used anthropometric indicator of size” at birth (WHO, 1995: 135), a standard measurement collected by biological anthropologists (Frisancho, 1990: 39–48), a common indicator of living conditions in today’s developed (UNICEF, 2007: 12–15) and underdeveloped nations (UNICEF, 2001: 82–85), as well as a frequent measurement employed by social science historians to investigate living conditions of people in the past (Mosk, 1996; Ward, 1993). After all, birthweight is also relatively easy to measure (United Nations Children’s Fund and World Health Organization, 2004: 3).

Materials and methods

Existing surveys known to have collected large anthropometric samples of North Koreans are shown in Table 1. All of these surveys are nationally-representative nutrition surveys, with the primary purpose of assessing as well as monitoring the status of well-being among North Korean pre-school children during and after the famine. Note that an earlier nutrition survey conducted in 1997 (Table 1) was discarded in the latter analysis since no birthweight data were collected at that time (Katona-Apte and Mokdad, 1998). Further note that a detailed discussion of these nutrition surveys has been provided elsewhere (Lee, 2017; Schwekendiek, 2009).

Most importantly, these nutrition surveys are based on random household samples (as opposed to the earlier survey based on pre-selected institutes). These surveys were implemented by North Korean authorities according to United Nations guidelines and with technical assistance from international organizations such as the World Food Program or the European Union. Nutrition surveys collecting birthweight data were carried out on a biennial basis from 1998 to 2004 as well as in 2009 and 2012 (Table 1). However, mean birthweight was only reported in 1998 (though it could be re-calculated for 2002 in this study using the raw dataset, see below). In 2000, 2002, and 2009, the prevalence of low birthweight (with a common cut-off for undernutrition of 2500 g as recommended by UN agencies such as UNICEF and WHO) was reported. However, in 2000 and 2004, neither mean birthweight nor prevalence of low birthweight was present in the official survey reports, even though birthweight was collected according to the survey questionnaires. In 2012, no birthweight data were collected throughout the survey, similar to the one conducted in 1997 (Table 1). Given these data reporting constraints, the latter analysis will focus on the birthweight time trend from 1998 to 2009, thus covering the peak-of-famine to post-famine period. Since raw data remain inaccessible, the analysis will be limited to plotting descriptive trends. However, to conduct an in-depth analysis, this research will employ raw data from the 2002 national nutrition survey, which was made available by the (then) Kim Jong-Il regime, primary owner of the dataset, to the author of the present study. Since sampled pre-school children were up to two years of age at the time of the survey, the latter analysis will focus on the birthyears of the children, which were 2000, 2001, and 2002 at that time.

As shown in Table 1, birthweight was either recalled by the child's mother or taken from the health card of the child in the course of the surveys (except for 1998, when it was only collected through memory recall). As to the 2002 survey, which was accessible to the author of this study, there is no information in the raw dataset if the survey teams entered birthweight by assessing the health card or according to memory recall of the mother. However, all mothers were additionally asked to indicate whether or not the reported birthweight was actually measured at birth. Among 2506 children below 2 years of age, 2495 (99.6%) individuals had their weights measured (Table 2). In developed nations, some 42% of newborns are measured, as opposed to 58% who are not measured at birth (United Nations Children’s Fund and World Health Organization, 2004: 9). Yet, this high rate of newborns measured in North Korea is not too surprising, as the communist government has provided free universal health care and set up hospitals throughout the entire country, meaning that babies are systematically born in hospitals (Hunter, 1999: 105) where they are routinely measured at birth. Nevertheless, to minimize the distortions caused by reporting, the remainder of this paper considers only individuals whose birthweights were actually measured at birth. As seen in Table 2, mean birthweight of children whose weight was reported-and-measured was lower (2938 g) than those whose weight was reported-but-unmeasured (3.420 g). Moreover, these “guesstimated” birthweights (Table 2) are extreme outliers, as indicated by their high standard deviation of 1998, further justifying their removal

Table 1
National nutrition surveys and birthweight in North Korea, 1997–2012.

Survey year	Historical period	Sampling unit	Birthweight of newborns					
			Data collected	Age of newborns	Method of data collection	Valid sample size	Mean in grams	Low birthweight in%
1997	Famine	Pre-selected institutes	No	n/a	n/a	n/a	n/a	n/a
1998	Famine	Random households	Yes	< 5 years	Recalled by baby's mother	1399	2800	9.0
2000	Famine to Post-Famine	Random households	Yes	< 12 months	Recalled by baby's mother	1238	n/a	6.4
2002	Post-Famine	Random households	Yes	< 24 months	Recalled by baby's mother or taken from health card	2506	2940*	6.7
2004	Post-Famine	Random households	Yes	< 24 months	Recalled by baby's mother or taken from health card	n/a	n/a	n/a
2009	Post-Famine	Random households	Yes	< 24 months	Recalled by baby's mother or taken from health card	854	n/a	5.7
2012	Post-Famine	Random households	No	n/a	n/a	n/a	n/a	n/a

Notes: *Data recalculated in this study, see Table 2; n/a = not available; low birthweight = newborns weighing below 2500 g.
Source: Various nutrition survey reports (in author's files).

Table 2
Birthweight of children in 2002 according to whether or not it was actually measured in 2002 as indicated by the mothers.

	Total	Weighed at birth	
		Yes	No
Number	2506	2495	11
Percent	100.0	99.6	0.4
Mean in grams	2940.22	2938.11	3420.09
Standard deviation	426.12	406.63	1998.63
Low birthweight in%	6.7	6.7	9.1

Notes: Data on 288 newborns were discarded since they had no birthweight data recorded, even though information on whether or not they were weighed at birth was collected.

from the following analysis.

Results

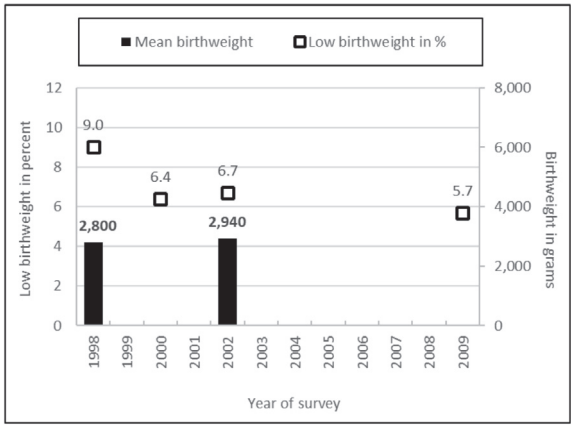
How has birthweight developed over time? Fig. 1 depicts the descriptive trend in mean birthweight in 1998 and 2002 (right *y*-axis) as well as the prevalence of low birthweight as a percentage from 1998 to 2009 (left *y*-axis). Expectedly, the prevalence of low birthweight peaked around the famine years, at 9% in 1998, when a drought hit the country after the nation experienced consecutive floods in the previous two years. Prevalence of low birthweight substantially and rapidly declined to 6–7% in the post-famine years of 2000 and 2002. Meanwhile, birthweight (right *y*-axis), which hovered at around 2800 g at the peak of the famine in 1998, similarly improved rapidly to 2940 g (thus by 5%) in the post-famine period of 2002. Prevalence of low birthweight then further declined to 5.7% in 2009.

The time trend in birthweight in the years 2000, 2001, and 2002 will now be investigated by making use of raw data from the nutrition survey of 2002. Table 3 shows the prevalence of low birthweight in these years, whereas Fig. 2 analyzes mean birthweight by birthyear.

As seen in Table 3, prevalence of low birthweight hovers at around 7% throughout the observed period. Overall, the prevalence of low birthweight seems to have stagnated during these three years. The chi-squared test indicates no statistically significant association between birthweights and birthyears.

Next, the time trend in mean birthweight is analyzed using error bars. As seen in Fig. 2, a stagnating trend can be observed similar to Table 2. However, while prevalence of low birthweight is worst in the year 2001 (Table 2), mean birthweight is the lowest in the year 2000, only improving slightly in the following 2 birthyears (Fig. 2). Overall, the error bar analysis confirms that there are no statistically significant differences across the observed periods.

Lastly, to further test for statistical significance, birthweight is regressed on a set of birthyear dummies (Table 4, Regression I) and a deterministic time trend variable (Table 4, Regression II). Individuals born in 2001 are 23.3 g heavier and those born in 2002 some 58.3 g heavier than those born in the base year 2000 (Table 4, Regression I). However, the differences are statistically not significant at the 1% or 5% levels, thereby corroborating the results of the error bar analysis that has shown a slightly upward trend that, however, does not statistically differ by birth periods. While the deterministic trend variable (Table 4, Regression II) is not statistically significant at the 1% level, it comes out significant at the 5%. However, even if the coefficient is significant at the 5% level, the



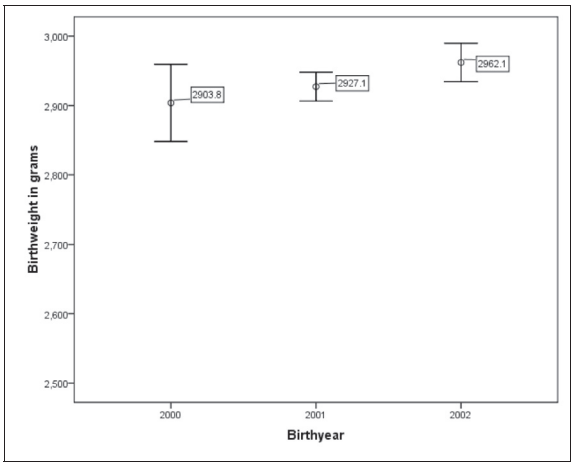
Notes: Low birthweight pertains to a birthweight below 2,500 grams.
Source: Various nutrition survey reports (in author's files).

Fig. 1. Trend in birthweight in North Korea, 1998–2009. Notes: Low birthweight pertains to a birthweight below 2500 g. Source: Various nutrition survey reports (in author's files).

Table 3
Contingency analysis of low prevalence of birthweight and birthyear.

		Birthyear:			
		2000	2001	2002	Total
Low birthweight:	No	95%	92%	94%	93%
	Yes	5%	8%	6%	7%
	Total	100%	100%	100%	100%

Notes: Chi squared = 4.407, p = 0.110, N = 2495. Low birthweight pertains to a birthweight below 2500 g.



Notes: Indicated is the 95% confidence interval.

Fig. 2. Error bar analysis of birthweight by birthyear, 2000–2002. Notes: Indicated is the 95% confidence interval.

Table 4
Linear regression of birthweight on birthyear dummies.

	Regression I	Regression II
Constant	2903.8140**	2001.1035**
Birthyear dummies		
In 2000	Reference	
In 2001	23.3017	
In 2002	58.2805	
Deterministic time trend		
Time trend variable		0.0001*
Adjusted *R* squared	0.0013	0.0017
N	2495	2495

Notes: * = significance at the 5% level, **significance at the 1% level. "Time trend variable": 2000 = 0, 2001 = 1, 2002 = 2.

size effect is negligibly small (0.0001 g).

Discussion

Statistical analysis has shown that birthweight remained quite stable in the early 2000s (Tables 3 and 4, Fig. 1). If so, the consistently small prevalence of low birthweight in North Korea bears a few comments. At about 7% in the early 2000s, North Korea's prevalence of low birthweight is much closer to that of industrialized nations (6%) than to developing (17%) or least developed (19%) nations at that time (UNICEF, 2001: 85).

Early explanations for the relatively low prevalence of underweight include deliberate political manipulation of the official survey report since "without access to raw data behind the 2002 nutritional assessment … it is impossible for outsiders to know what actually happened" (Eberstadt, 2007: 51). However, as shown herein as well as in previous studies (Shrimpton and Kachondham, 2003), independent data analysis has confirmed the results of the official survey report, casting doubt on the government manipulation hypothesis.

Furthermore, the finding that birthweight was reported by the child's mother instead of actually being measured might have caused some distortions. However, to mitigate this effect, this research only included cases in which birthweight was actually measured as claimed by the mothers of the children. Needless to say, we cannot rule out the possibility that the respondents might have biased their reports.

Yet, a more severe concern is that even if birthweights were measured at birth, the scales used were probably not sufficiently precise. According to the (inaccessible) nutrition survey of 1998, "there was a strong tendency to round off birthweights" (UNICEF, 1998: 6) at that time. The same issue is also prevalent in the 2002 survey, where birthweight was mostly reported in increments of 100 g units (e.g., 2500 or 2700 g) and rarely in increments of 10 g units (e.g., 2520 g or 2720 g). As mentioned above, although the vast majority of women in North Korea indeed give birth in hospitals, where newborns are routinely measured with scales and their birthweights systematically recorded on their health cards, a critical fact is that hospitals are catastrophically underfunded as a result of the looming economic crisis (Mohr, 2000). This suggests that North Korean hospitals are very likely using analogue, thus arguably antiquated, scales. UNICEF and the WHO recommend using digital scales with a measurement precision of 10 g to assess birthweight, while also suggesting that rounding is often a result of (less easily readable) spring scales (United Nations Children's Fund and World Health Organization, 2004: 21). Removing all birthweights from the 2002 sample that are apparently based on rounded entries (as indicated by two "zero" digits at the end, for instance 2500, 2600, 2700) substantially reduces the sample size from 2495 to 285 observations. Mean birthweight drops slightly from 2940 g (Fig. 1) to 2850 g, thus by just 90 g. However, the prevalence of children with a low birthweight now rises from 6.7% (Fig. 1) to 16%. The latter figure is quite close to developing (17%) or least developed (19%) nations at that time (UNICEF, 2001: 85). With that in mind, it seems that technical issues (i.e., rounding due to less easily readable spring scales) are likely to have created anthropometric distortions.

In addition, a possible socio-economic explanation for the relatively "good" prevalence of low birthweight is that households deliberately postponed or canceled family planning during and after the crisis years, resulting in higher fertility rates among financially stable households. As household resources and child birth are likely positively correlated, this in turn might also explain the relatively small prevalence of low birthweight in North Korea. A recent study found total fertility levels dramatically declined from about three children per woman in the pre-famine period of 1980 to about two children per woman in the post-famine year of 2009 (Spoorenberg, 2014), indicating an extreme demographic transition within a short period of time. If so, there must have been very strong environmental forces at work, calling for further investigations.

Along similar lines but beyond socio-economic drivers, a simple human biological explanation could be that the food crisis of the 1990s per se might have caused infertility among poorer North Korean women, thus systematically resulting in a higher proportion of births among wealthier and healthier babies. For instance, according to declassified interviews of North Korean defectors and foreign visitors, some 10–15% of wives were unable to become pregnant in the "golden" 1960s as a result of overwork and undernutrition (Hunter, 1999: 104). This infertility rate would be correspondingly higher in the 1990s, when the nation was going through a great famine. Hence, nutrition-related fertility patterns might also explain the relatively small prevalence of low birthweight in North Korea.

Last but not least, a direct comparison with North Korea's "twin" in the South literally suggests itself. In fact, mean birthweight was about 3257 g (Baek et al., 2015: 28), and prevalence of low birthweight about 3.5% (Baek et al., 2015: 14) among babies born in the 2000s in South Korea. Hence, it is safe to say that North Korean newborns, at a mean birthweight of 2940 g (Fig. 2) and a prevalence of low underweight of 6.7% (Table 3), were noticeably lagging behind their Southern peers at that time.

More importantly, the latter finding verifies the aforementioned comparative studies investigating height, weight, body-mass index (Schwekendiek and Pak, 2009), mid-upper arm circumference (Schwekendiek, 2013), longevity (Schwekendiek, 2018), and age at menarche (Ku et al., 2006) in the two Koreas, all of which reached the conclusion that biosocial living conditions are systematically and strikingly better in the economically developed South.

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