DRAFT - not to be quoted without permission of the authors

MATERNAL FACTORS RELATED TO DIFFERENT TRENDS IN NEONATAL MORTALITY AND LOW BIRTH WEIGHT

Carol J.R. Hogue, Ph.D.
Assistant Professor of Biometry
University of Arkansas for
Medical Sciences
Little Rock, AR 72201

Allen Wilcox, M.D.
Graduate Student
Department of Epidemiology
University of North Carolina at Chapel Hill

L. Scott Muller, B.A.
Graduate Student
Department of Economics
University of North Carolina at Chapel Hill

Prepared for presentation at the Eighth
International Scientific Meeting of the
International Epidemiological Association
San Juan, Puerto Rico,
September 22, 1977

In past studies, various factors have been examined for their effect on birth weight (BW) and, to some extent, for their effect on neonatal mortality (NM), death in the first twenty-eight days after delivery (Figures 1 and 2). We know that infants with lower birth weights are at higher risk of NM (Figure 3), and it would seem logical to conclude that factors which cause a reduction in BW also cause an increase in NM because of the reduced BW (Figure 4). But past studies have indicated some problems with this conclusion. For example, we know that males tend to be heavier than females but they also tend to be more likely to succumb in the first twenty-eight days after birth. For the factor "sex," we find the relationship pictured in Figure 5.

Looking at another factor, investigators have found that, for a given low BW, blacks in the United States are more likely to survive than are whites of the same BW. Thus, the relationship between maternal and infant socio-demographic factors and mortality in the first month of life seems to be more complex than one would at first imagine.

It perhaps should not then be surprising that trends in low BW and NM have not been moving in the same direction during recent years. Mortality has been declining while low BW has tended to remain the same. For example, between 1955 and 1973 the NM mortality rate for the U.S. declined 36 percent, from 26.4 deaths/1000 live born to 16.7 deaths/1000 live born. In North Carolina the trend was about the same; between 1957 and 1973 the NM rate declined almost 25 percent, from 20/1000 to 15.5/1000. The low BW incidence stayed about the same (86/1000) over the period.

These trends suggest one or both of the following hypotheses:

(1) some factors which decrease BW but do not increase NM have been increasing in frequency while other factors which decrease BW and also increase NM have been declining in frequency. Briefly, among correlates of BW, there is occurring a substitution of non-lethal factors for lethal ones.

(2) some factors which increase the risk of NM are independent of BW; these factors are declining while BW remains relatively stable.

Material and Methods

We investigated these hypotheses, using some of the most commonly associated maternal factors (plus sex of the infant) and data routinely collected from vital statistics in North Carolina during the years 1962 through 1974. We obtained a census of all resident, singleton, live births weighing 2500 grams or less and a ten percent random sample of all resident, singleton, live births weighing more than 2500 grams. We also collected data on all fetal deaths during the period, but these are not included in this presentation. For this analysis we limited births to Negro or Caucasian races, thereby excluding approximately two percent of the total.

In addition to the information coded from live birth certificates, the records included age at death, if the infant died during its first year, and also cause of death. Because low BW is related more strongly to early deaths, we examined deaths occurring prior to twenty-nine days. (Post-neonatal deaths were included with the other survivors.) The compilation of these data required considerable effort even though infant death certificates are routinely linked to birth certificates in North Carolina. In order to determine the sample of survivors, records were re-linked in the other direction, that is, eliminating deceased from the live birth pool to obtain the group of survivors.

One disappointment with these data was our inability to obtain accurate information on gestation. Gestation was recorded in weeks, with so much heaping at certain values that it could not be considered to be reliable. Another problem was that BW was recorded in 500-gram categories, which reduces the accuracy of our estimates. Also we did not have data on several important maternal factors, such as weight and smoking behavior. Table 1 lists the variables which we did include in several multiple regression models of BW and NM. The variables included in the models from 1968-1974 were not measured prior to 1968.

All individual regressions were fit by Ordinary Least Squares. Since the equations have limited dependent variables the disturbance terms are non-normally distributed. The properties of the estimates in this paper are as follows: $\hat{\beta}$ (the OLS coefficients) and S^2 (the sample variance) are unbiased and, in large samples, consistent. In large samples the estimates are asymptotically normally distributed and thus the t and F statistics are asymptotically correct. The average size of the samples employed in this analysis is 15,000 observations, which qualifies as a large sample and the asymptotic properties do hold in this analysis. The only loss by employing OLS is in efficiency. A case was included for estimation only if all values of the variables were known. The computer package employed was SAS (Statistical Analysis System).

Special procedures are available to deal with non-normally distributed disturbance terms (e.g. Probit, Logit, etc.) however the cost of using these programs would be prohibitive.

Results

In presenting the results of our analysis, let me say at the outset that they are preliminary in nature. Refinements of the results will be available at a later date.

Let us first consider the second hypothesis, namely that some factors which increase the risk of NM are independent of BW. Graphs 1 and 2 indicate the NM rate for low BW births and the normal BW sample. For normal-weight deliveries, NM declined from 5 per 1000 to 3.4 per 1000, a decline of 32.7 percent. For births weighing 2500 grams or less, the decline was from 148 per 1000 to 121.6 per 1000, a 17.8 percent drop. The absolute decline in NM for low BW births was 16.5 times greater than the absolute decline in NM for normal-weight births, so, although the low BW births comprise only about 8 percent of the total number of births in the state, the overall absolute decline in NM for this period was twice as great for low BW deliveries than for normal-weight births. (That is, if the 1962 NM rates were applied to the 1974 births, there would have been 531 additional neonatal deaths among low BW births and 240 additional deaths among normal-weight births.) With respect to hypothesis two, we can conclude that there are factors exogenous to birth weight which are advantageously affecting the NM rate. But, also, low BW remains a great risk factor for NM, a light-weight baby being 36 times more likely to die.

Considerable effort has been applied to the identification of risk factors for low BW, with the implicit assumption being that if one is able to reduce those factors, then NM will also be reduced. But we have already seen that if one could reduce the number of females, low BW might decline but NM might increase. As an approach to the problem of the effect of BW correlates on NM, we used multiple regression analysis to estimate BW with available socio-demographic factors. We also used those factors to estimate NM, but also included BW as a variable in the NM model so that the partial correlation coefficients of the socio-demographic variables would reflect their impact on NM, accounting for BW. (In analysis not presented today, we ran a three-stage system of regression equations to estimate simultaneously BW and NM, using the estimated BW as a predictor for NM.) Although many previous investigators have looked at these variables only one at a time, very little of what we found with respect to predicting BW in these multiple regression equations is new. Race, sex, age of the mother, parity, previous fetal loss and maternal education were partially correlated with BW in directions which other investigators have reported. We also included season of birth, place birth occurred, and information on antenatal care. Perhaps the most surprising result was that being illegitimate reduced BW in the smaller BW model but increased it in the larger BW model, when education and prenatal care were added to the model. The multiple regression coefficients are given in your handout, along with the R^2 values. Discouraging but also not surprising were the small amounts of variance explained by these variables. For the little model, the highest R^2 was .0737 in 1974, while the highest R^2 for the larger model was .2255 in 1971. Clearly these variables do not explain the great majority of low BW deliveries, although several of them do explain a significant amount of variance. The next figure shows that the smaller model of BW closely estimates the average observed BW, while the larger model considerably deviates from the observed values. (As an aside, I should point out that these graphics are drawn so as to emphasize differences.)

For NM, only the smaller model is displayed in the next graph and in the succeeding table of regression coefficients. (The R^2 values for the larger model corresponding to the larger of the BW models were very similar to those for the smaller NM version, and we decided that the additional variables were therefore superfluous.) With BW and BW^2 in the equations, these NM models explain as much as 39 percent of the variance in NM. As well, estimated rates of NM fairly closely track the observed values.

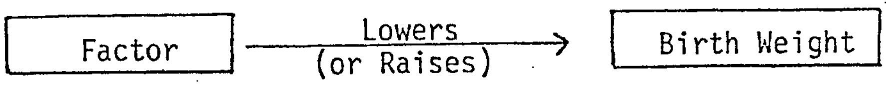
Returning to Table 1, one can see that only one variable--the squared term for age of mother--both reduces BW <u>and</u> increases NM. Four terms have opposite effects on BW and NM. They are race and sex, legitimacy status and location of the birth. We must conclude that these latter commonly measured correlates of BW are not risk factors for NM except as they affect BW. The extent to which the <u>estimated</u> BW based on these factors affects NM is the subject of the system of regressions problem to which I alluded earlier. I can report that they play an insignificant role through this route.

The final bit of information that I will present today regarding these maternal factors and NM has to do with time trends in the factors. We had originally hoped to demonstrate that "lethal" correlates of low BW are decreasing while "non-lethal" correlates are on the rise. The only "lethal" correlate of low BW we could uncover was the squared age of the mother. It, indeed, has declined by about 12 percent over the time period. As you can see on the final two graphs, race (a "non-lethal" factor) has remained about the same, while the proportion illegitimate has steadily grown. There also appears to be a decrease over time in the amount of reduction in BW due to illegitimacy status.

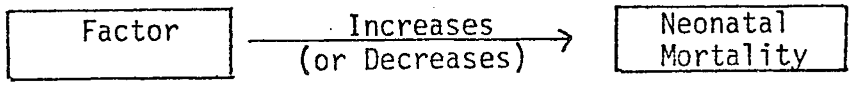
We plan to pursue this avenue a little further to see how much of the decline in NM could be explained by changes in the factors, but we will not pursue the question very much further since our chief conclusion from this investigation is that correlates of low BW are not necessarily correlates of increased NM; instead of additional studies of these commonly measured factors and their associations with BW, we should really study NM *per se* and explore its risk factors in much greater depth.

The authors gratefully acknowledge the assistance of Charles Rothwell, Chief of the North Carolina Public Health Statistics Branch, John Young and their associates, for compiling the data sets for this analysis.

In past studies, factors have been examined for their effect on birth weight (BW) and, to some extent, for their effect on neonatal mortality (NM).

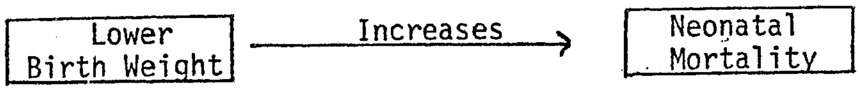


(1)



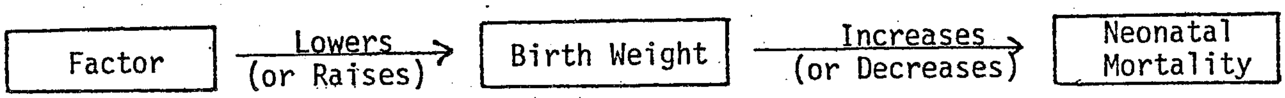
(2)

We know the relationship holds:



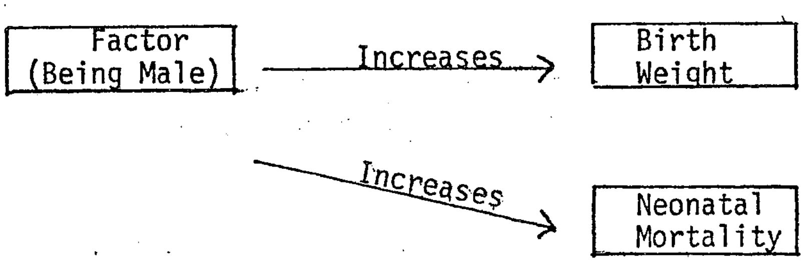
(3)

It would seem logical to conclude the following:



(4)

But past studies have indicated some problems with this conclusion. For example, we know that males tend to be heavier than females but that they also tend to be more likely to succumb in the first twenty-eight days after birth. In this case, the following relationship holds:



(5)

Also, investigators have found that, for a given <u>low</u> birth weight, blacks in the United States are more likely to survive than are whites. Thus, the relationship between maternal and infant socio-demographic factors and mortality in the first month seems to be more complex than one would at first conclude.

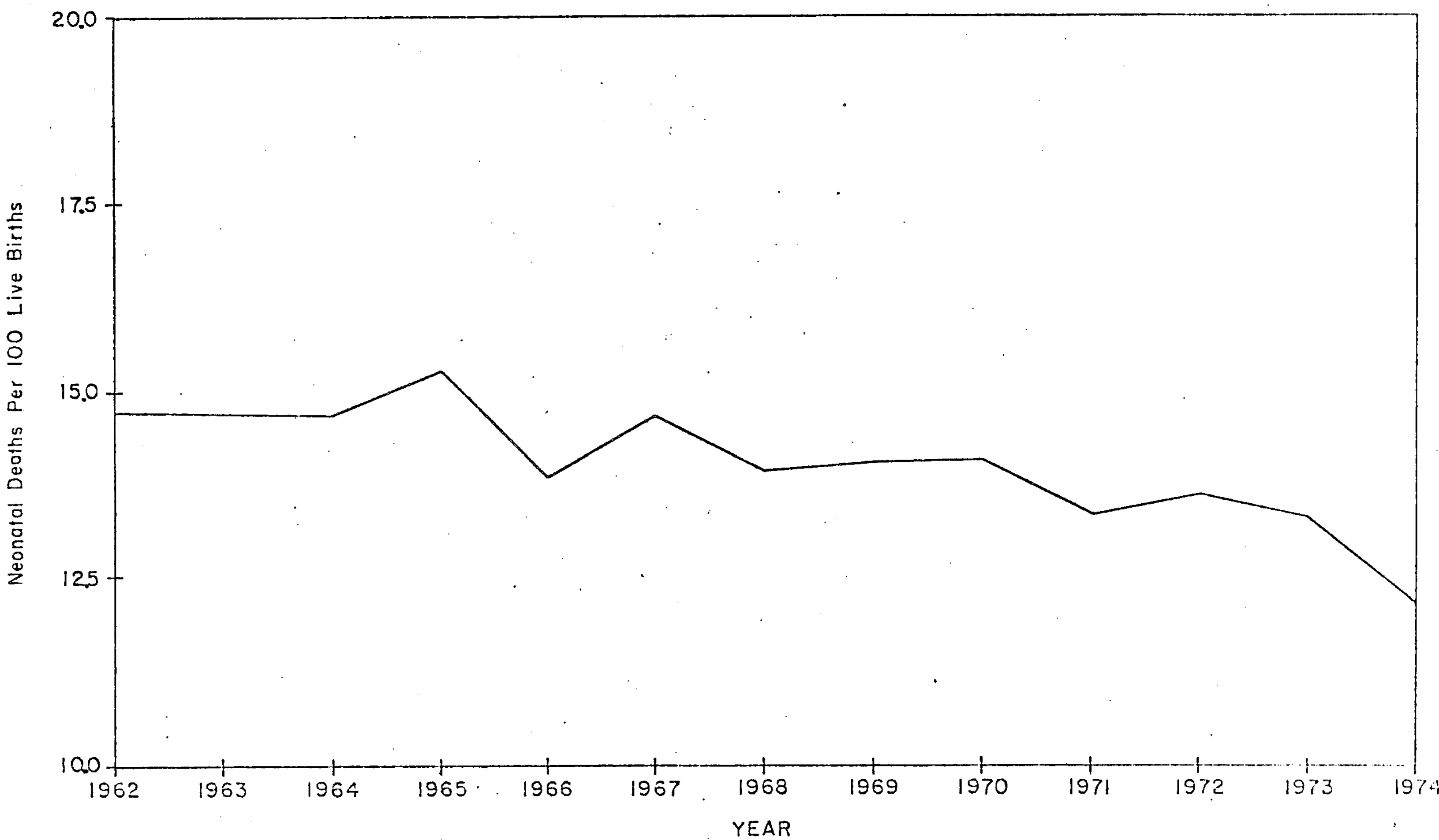
TABLE 1. Summary Table of Variables Included in Multiple Regression Models and Number of Times the Partial Correlation Coefficient was Significant*

Independent Variables	Dependent Variable in the Model (Years Estimated)		
	Birth Weight (1968-1974)	Birth Weight (1962-1974)	Neonatal Mortality (1962-1974)
Race (non-white = 1)	7 (-)	13 (-)**	13 (-)
Sex (male = 1)	7 (+)	13 (+)	13 (+)
Age of Mother	4 (+)	13 (+)	2 (o)
Age of Mother Squared	5 (-)	13 (-)	1 (+)
Parity	7 (+)	1 (o)	7 (+)
Parity Squared	6 (-)	1 (o)	4 (-)
Legitimacy Status (illegitimate = 1)	3 (+)	13 (-)	7 (-)
Experience of Previous Fetal Loss (yes = 1)	7 (-)	13 (-)	0 (o)
Season of Birth: Fall	2 (-)	0 (-)	----***
Spring	0 (o)	1 (-)	----
Summer	4 (-)	7 (-)	----
Birth Occurring at a General Hospital	7 (-)	10 (-)	11 (-)
Education of Mother	7 (+)	----	----
Trimester Care Began: First	7 (-)	----	----
Second	1 (-)	----	----
Third	7 (+)	----	----
Number of Prenatal Care (PNC) Visits	6 (+)	----	----
PNC Visits Squared	7 (+)	----	----
Birth Weight	----	----	13 (-)
Birth Weight Squared	----	----	13 (+)

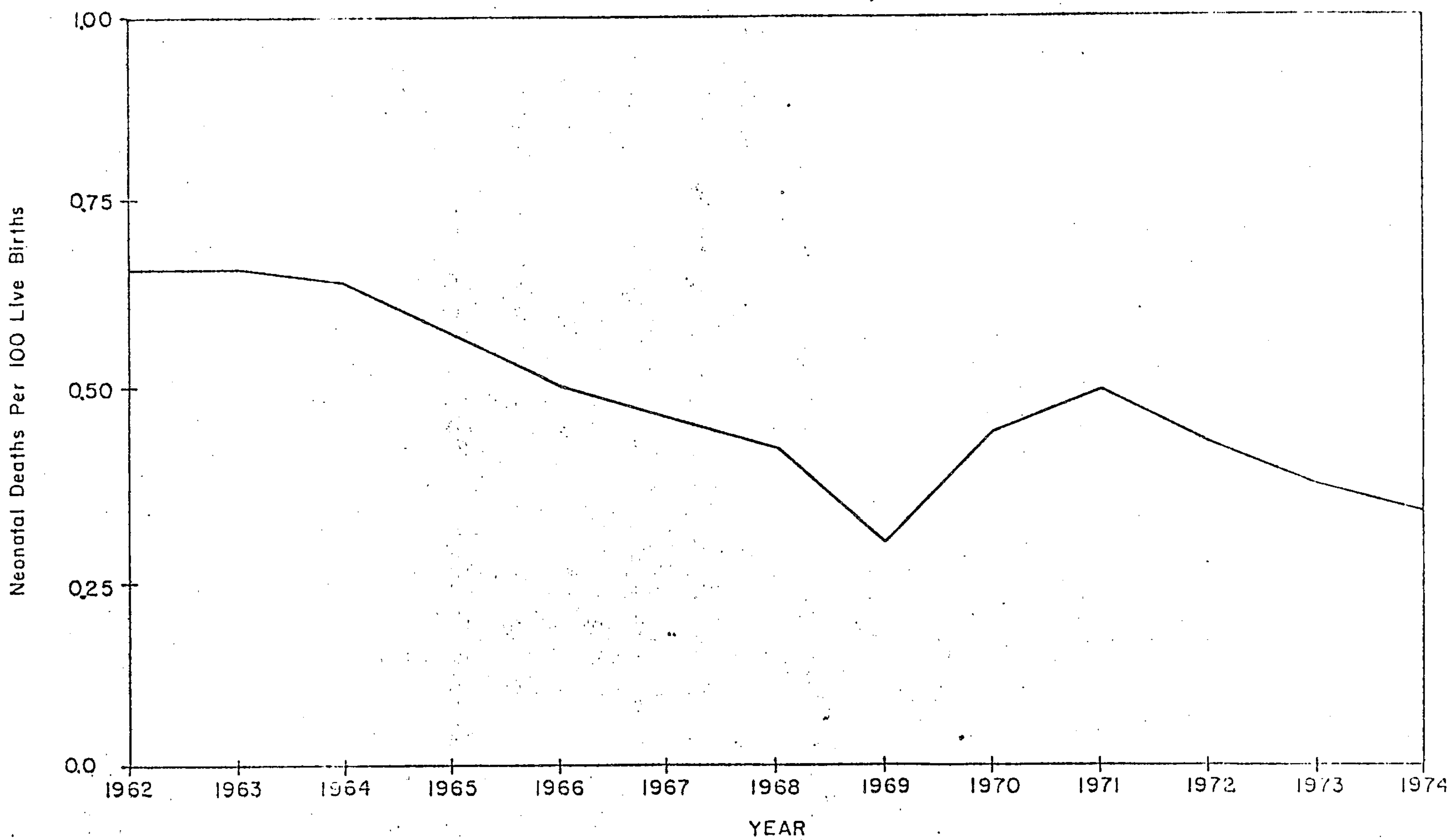
*(|T| > 1.96)

**Indicates direction of association:
- = lower birth weight or lower probability of mortality
o = no consistent direction of association

***Variable was not included in the model



Observed Neonatal Deaths Per 100 Live, Low Weight (≤2500 g) Births, North Carolina Sample, 1962–1974



Observed Neonatal Deaths Per 100 Live, Normal Weight (>2500 g) Births,
North Carolina Sample, 1962–1974

REGRESSION COEFFICIENTS FOR (BIG) BIRTHWEIGHT MODEL (T-statistic in parentheses)

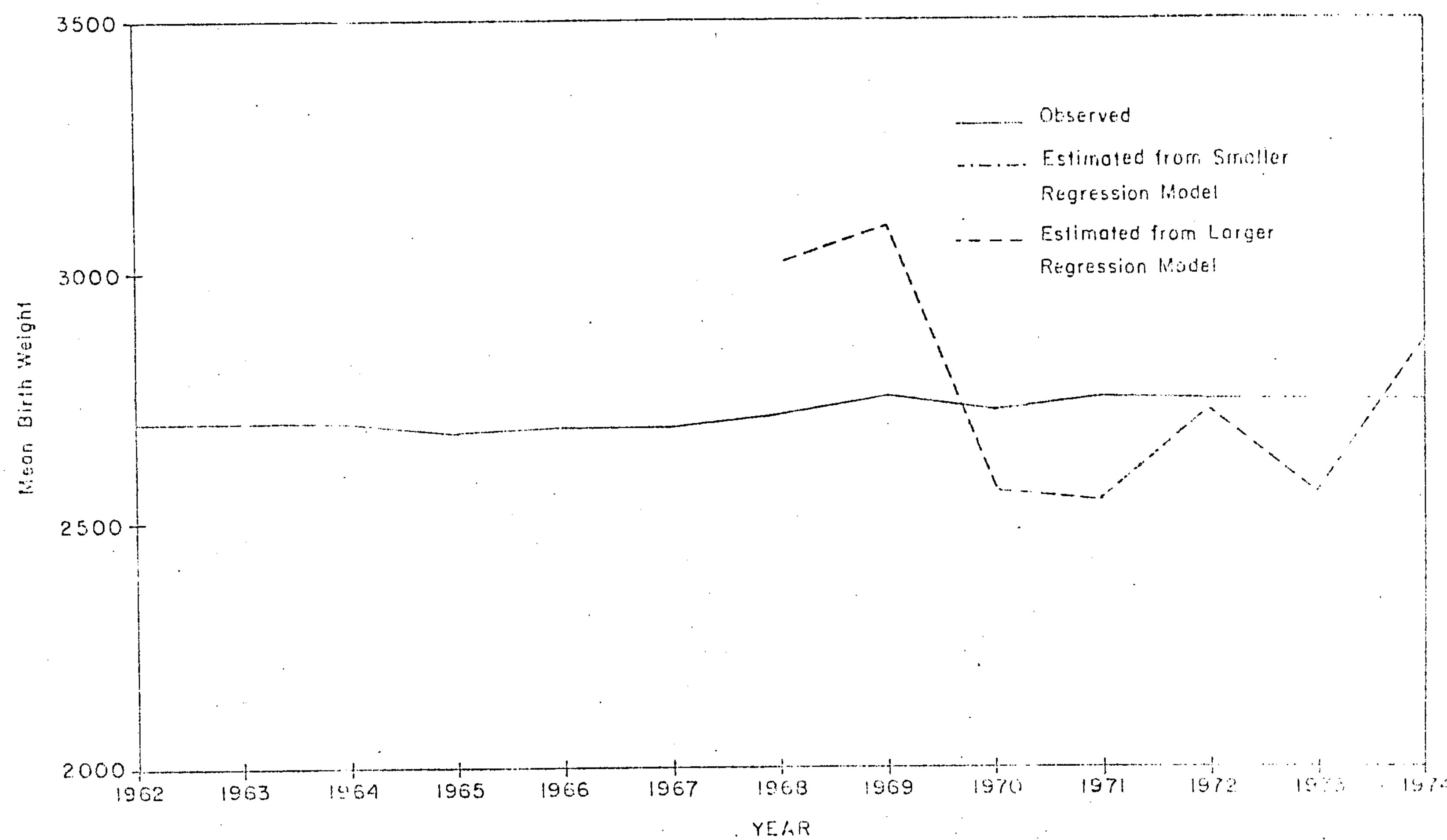
	YEAR						
	68	69	70	71	72	73	74
Intercept	1980.13104625	2040.62261975	1625.74716165	1689.45792934	1540.26897703	1510.36750242	[illegible]
Race	-115.49663013 (-7.46305)	-114.29970324 (-7.25198)	-129.09352014 (-8.61109)	-129.67971553 (-8.57333)	-171.11019755 (-11.10964)	-166.33892857 (-10.63093)	-230.[illegible] (-12.[illegible])
Sex	107.35114998 (8.69492)	110.02559704 (9.07111)	109.07881734 (9.29289)	123.74237780 (10.55311)	124.19507936 (10.20275)	121.50657539 (9.68531)	114.62017200 (8.88917)
Age of Mother	11.73954095 (1.34085)	9.92439244 (1.13026)	31.12121585 (3.48029)	30.61436383 (3.47108)	24.86656877 (2.74284)	31.83590427 (3.34753)	18.72698644 (1.89439)
Age of Mother Squared	-0.25828830 (-1.65411)	-0.27960653 (-1.77502)	-0.59449414 (-3.63829)	-0.67503068 (-4.18829)	-0.54548595 (-3.27676)	-0.65270759 (-3.68876)	-0.42901333 (-2.33931)
Parity	82.87117938 (8.02988)	90.91667309 (8.84903)	66.78263967 (6.92471)	84.50788416 (8.13082)	79.82355866 (6.93641)	70.40332459 (6.07422)	61.75640535 (4.84147)
Parity Squared	-4.32552856 (-5.14023)	-4.16121477 (-4.95681)	-1.94386416 (-2.45848)	-4.02024233 (-4.52794)	-3.57515692 (-3.33672)	-2.54946855 (-2.46421)	-0.80366419 (-0.64306)
Legitimacy Status	35.17952740 (1.64602)	51.75011752 (2.49911)	40.38847584 (2.05933)	21.21417583 (1.07462)	34.88800601 (1.75408)	33.28431349 (1.65914)	51.90160714 (2.53415)
Previous Fetal Loss	-256.23755463 (-13.11883)	-251.05285628 (-12.77842)	-244.15643180 (-12.91050)	-246.64767380 (-13.07328)	-237.05003258 (-12.15826)	-221.67874132 (-10.81230)	-220.63552863 (-10.87372)
Fall Delivery	-55.72163718 (-3.02517)	-17.00012775 (-0.93505)	-22.73733655 (-1.31816)	-40.40607823 (-2.29396)	-11.29783740 (-0.61591)	-36.07361943 (-1.90739)	-36.39490106 (-1.89468)
Spring Delivery	-12.21204971 (-0.72962)	-0.40622714 (-0.02471)	6.97716178 (0.43389)	16.35401784 (1.03967)	-8.88128962 (-0.54735)	-14.40656871 (-0.85939)	-23.28708326 (-1.33494)
Summer Delivery	-88.46810900 (-5.49225)	-23.85089515 (-1.51452)	-38.00614057 (-2.49588)	-16.78521329 (-1.10147)	-20.27518175 (-1.27573)	-55.68621646 (-3.40327)	-74.19156490 (-4.42974)
Birth in General Hospital	-397.31250447 (-9.75314)	-337.75063102 (-7.55852)	-291.91159432 (-6.30441)	-374.55911969 (-7.42689)	-215.10222782 (-4.04697)	-129.83058057 (-2.36330)	-254.81442484 (-4.02634)
Education of Mother	9.30699078 (2.85769)	10.25078904 (3.14675)	9.13525957 (2.81462)	15.97338353 (4.84184)	19.72277060 (5.70055)	12.94552997 (3.59372)	20.00728636 (5.23324)
Care Began First Trimester	-261.68809397 (-2.66175)	-364.74272851 (-3.17465)	-207.00279317 (-3.48007)	-248.99039489 (-4.27229)	-182.67909528 (-3.02692)	-242.69305335 (-3.80793)	-329.03289925 (-5.02316)
Care Began Second Trimester	-30.58782608 (-0.31334)	-153.53378060 (-1.34268)	20.56300244 (0.34907)	-0.48146064 (-0.00837)	39.47400167 (0.66301)	-16.40341347 (-0.26066)	-130.75634594 (-2.01710)
Care Began Third Trimester	332.88163240 (3.43636)	237.65195265 (2.08452)	439.92310778 (7.60308)	414.83199935 (7.32224)	453.77440094 (7.69290)	335.83501997 (5.47530)	294.[illegible] (4.61517)
Number of PNC Visits	106.75806930 (8.46045)	90.26142402 (7.03615)	45.94596343 (3.16660)	48.56365826 (3.29371)	41.53856358 (2.62413)	39.26063619 (2.33266)	15.65541060 (0.91271)
PNC Visits Squared	2.13152546 (2.22596)	3.93664235 (4.04955)	9.75872642 (8.00557)	10.02321881 (8.13290)	10.20041473 (7.72969)	10.60426384 (7.63262)	13.02940662 (9.14453)
R^2	0.1881	0.1956	0.2078	0.2255	0.2192	0.2171	0.2215
DF for Error	14081	14484	15883	15305	14810	14001	13450

REGRESSION COEFFICIENTS [illegible] (LITTLE) BIRTHWEIGHT MODEL (T-statistic in parentheses)

	YEAR						
	62	63	64	65	66	67	68
Intercept	1961.[illegible]047532	2155.79234428	1936.43647714	2228.16057987	1855.43935635	2021.08970870	2152.11[illegible]1524
Race	-274.99105753 (-18.3[illegible]87)	-296.70135128 (-19.88005)	-249.02277705 (-16.72852)	-291.48760379 (-18.81344)	-272.36200981 (-17.39591)	-256.2720294[illegible] (-16.49249)	-257.[illegible]489 (-15.[illegible])
Sex	85.32115657 (7.23788)	76.10366525 (6.39405)	88.48192273 (7.44612)	97.64344859 (7.89297)	97.46878507 (7.69307)	105.14450626 (8.26106)	96.30[illegible]77176 (7.2[illegible])
Age of Mother	79.74954260 (10.31247)	60.43920892 (7.75941)	74.38981500 (9.57291)	51.59509564 (6.54475)	86.30466811 (10.54454)	64.00306701 (7.41311)	56.36[illegible]9914 (6.71497)
Age of Mother Squared	-1.29657880 (-9.35459)	-0.97359713 (-6.95845)	-1.16837622 (-8.35268)	-0.77917407 (-5.49728)	-1.45132755 (-9.75698)	-1.03954512 (-6.56548)	-0.[illegible]0321 (-5.0[illegible])
Parity	14.13734760 (1.73393)	10.53559156 (1.31448)	-4.69991533 (-0.57384)	6.87515728 (0.80048)	-6.61820630 (-0.77397)	9.22685162 (0.96934)	16.77229126 (1.62063)
Parity Squared	-0.58336551 (-0.86198)	-0.79188534 (-1.29231)	0.11787283 (0.18701)	-0.16038841 (-0.24124)	1.03356105 (1.57510)	-0.79275579 (-1.00646)	-1.56199372 (-1.75180)
Legitimacy Status	-73.[illegible]573406 (-3.56023)	-117.43471403 (-5.70000)	-141.58882869 (-7.08538)	-99.07145202 (-4.82230)	-90.45290622 (-4.43262)	-122.39506705 (-6.02091)	-68.57[illegible]6626 (-3.0[illegible])
Previous Fetal Loss	-211.4[illegible]13506 (-12.1[illegible]89)	-195.47948771 (-10.97132)	-175.42279073 (-9.69166)	-185.89638856 (-10.01628)	-193.65122349 (-9.70082)	-214.25949828 (-10.57045)	-223.0[illegible]5291 (-10.5[illegible])
Fall Delivery	1.[illegible]09991 (0.[illegible])	-27.81548860 (-1.55711)	-29.59729540 (-1.64333)	-10.25065183 (-0.54077)	-12.12975371 (-0.63680)	-2.15582947 (-0.11304)	-36.1[illegible]190 (-1.[illegible])
Spring Delivery	35.[illegible]7136246 (2.27151)	7.53638623 (0.47151)	-15.91786594 (-0.98931)	-13.21496160 (-0.80215)	-20.24759389 (-1.18503)	-33.29677429 (-1.93343)	-13.17[illegible]213 (-0.7[illegible])
Summer Delivery	-22.25799725 (-1.44161)	-25.23709515 (-1.62651)	-41.52961745 (-2.69869)	-35.36237947 (-2.19071)	-53.80708054 (-3.26316)	-32.11724290 (-1.94001)	-79.97408493 (-4.59730)
Birth in General Hospital	-245.[illegible]1563431 (-9.84499)	-227.96957044 (-8.98629)	-197.75509772 (-7.42525)	-216.78373714 (-7.46772)	-242.61967710 (-7.58885)	-143.66079913 (-4.15032)	-207.48671376 (-4.75369)
R^2	0.0[illegible]08	0.0532	0.0539	0.0545	0.0552	0.0542	0.052[illegible]
DF for Error	18464	18185	18080	16741	15923	15966	140[illegible]7

(Continued)
REGRESSION COEFFICIENTS FOR (LITTLE) BIRTHWEIGHT MODEL (T-statistic in parentheses)

	YEAR					
	69	70	71	72	73	74
Intercept	1964.36915011	1636.77872329	1664.90873863	1582.61169547	1585.35034871	1731.32335422
Race	-277.11762358 (-16.76454)	-290.53904633 (-18.45002)	-269.73070875 (-16.73221)	-300.10141554 (-18.36308)	-282.19596916 (-16.77698)	-326.42263726 (-18.85207)
Sex	101.57434879 (7.71840)	91.70957693 (7.19304)	116.54878935 (9.05869)	113.47286685 (8.55028)	120.83370404 (8.84101)	104.07402484 (7.40434)
Age of Mother	65.89975132 (7.95769)	93.99867031 (10.52505)	97.17469702 (10.90087)	91.39787968 (10.05942)	89.62668960 (9.43032)	87.62924604 (8.95707)
Age of Mother Squared	-1.14346660 (-7.09046)	-1.52661238 (-9.13168)	-1.64767919 (-9.86322)	-1.51612088 (-8.85007)	-1.47084539 (-8.08092)	-1.43899731 (-7.66200)
Parity	13.58517377 (1.31159)	-1.66954789 (-0.17167)	2.41891177 (0.22823)	-8.20287445 (-0.69710)	-20.25037527 (-1.71664)	-26.08527531 (-2.00740)
Parity Squared	-1.00931129 (-1.12886)	0.62434001 (0.73973)	-0.83828646 (-0.87630)	0.47277351 (0.41076)	1.25168493 (1.12478)	2.75981015 (2.05159)
Legitimacy Status	-60.37741099 (-2.73257)	-72.51658695 (-3.49716)	-103.90328556 (-4.93383)	-80.05647799 (-3.77505)	-93.93036648 (-4.40193)	-70.53142309 (-3.22383)
Previous Fetal Loss	-194.86594343 (-9.21550)	-194.22567820 (-9.51506)	-196.54985077 (-9.57422)	-199.89865495 (-9.47796)	-155.34734174 (-7.01699)	-168.55521896 (-7.50362)
Fall Delivery	-15.55465376 (-0.78892)	-27.81603416 (-1.48413)	-26.08707806 (-1.34997)	-20.81841420 (-1.04095)	-38.71251734 (-1.87868)	-29.30544145 (-1.39947)
Spring Delivery	-0.20346470 (-0.01141)	-6.49327111 (-0.37167)	22.31607401 (1.29281)	-20.11979522 (-1.13724)	-10.61399444 (-0.58113)	-25.18174876 (-1.32400)
Summer Delivery	-20.26666497 (-1.18619)	-31.79288762 (-1.92183)	-19.90225469 (-1.19016)	-38.94739064 (-2.24816)	-45.34186610 (-2.54366)	-62.36112664 (-3.41560)
Birth in General Hospital	-157.04262607 (-3.25678)	-133.33967516 (-2.66049)	-154.43363124 (-2.80116)	25.57276047 (0.44449)	46.42451159 (0.77837)	-49.74876919 (-0.72286)
R^2	0.0522	0.0640	0.0668	0.0712	0.0700	0.0737
DF for Error	14490	15889	15311	14816	14007	13456



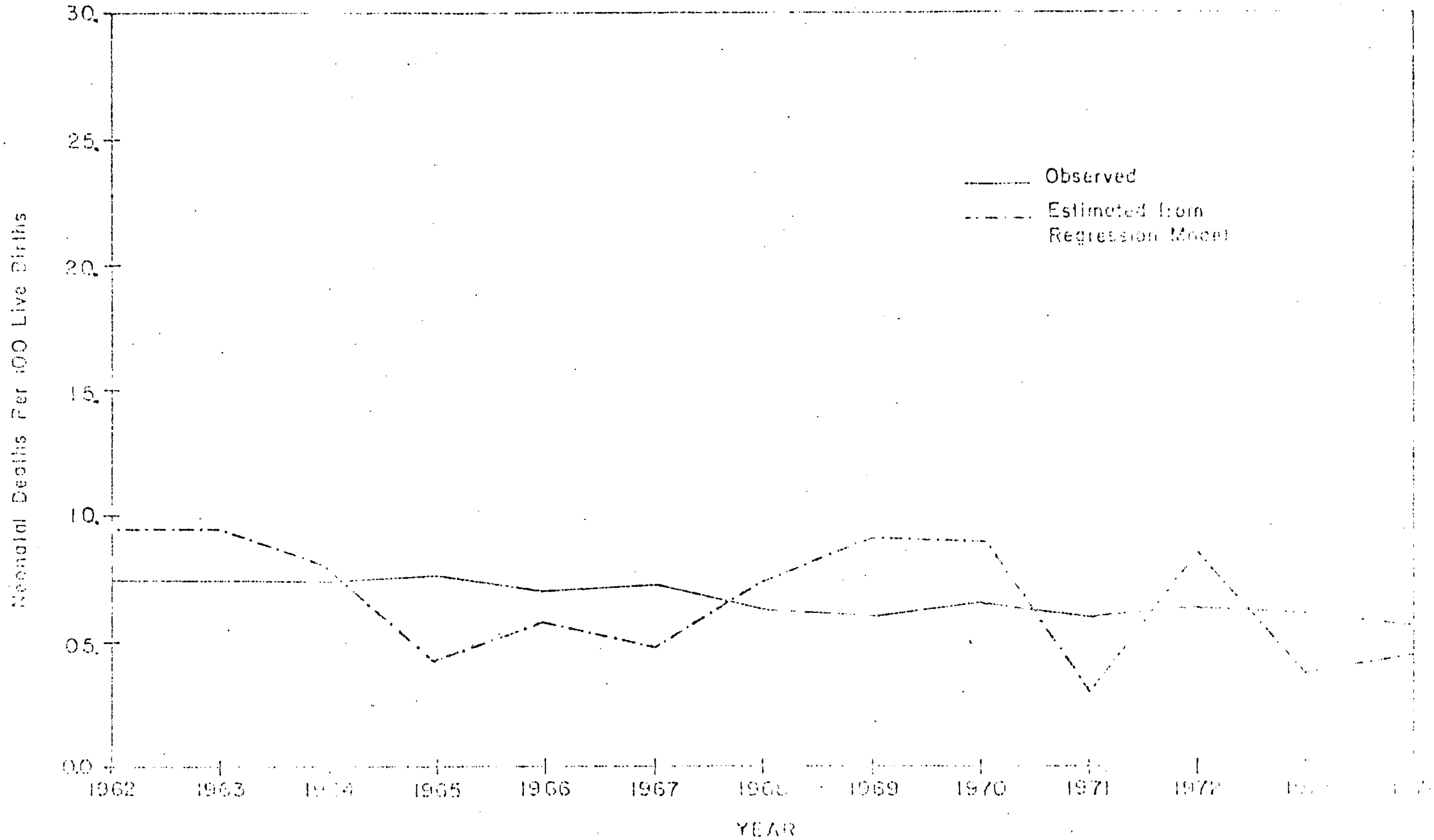
Observed and Estimated Mean Birth Weights,
North Carolina Sample, 1962-1974

REGRESSION COEFFICIENTS FOR NEONATAL MORTALITY MODEL (T-statistic in parentheses)

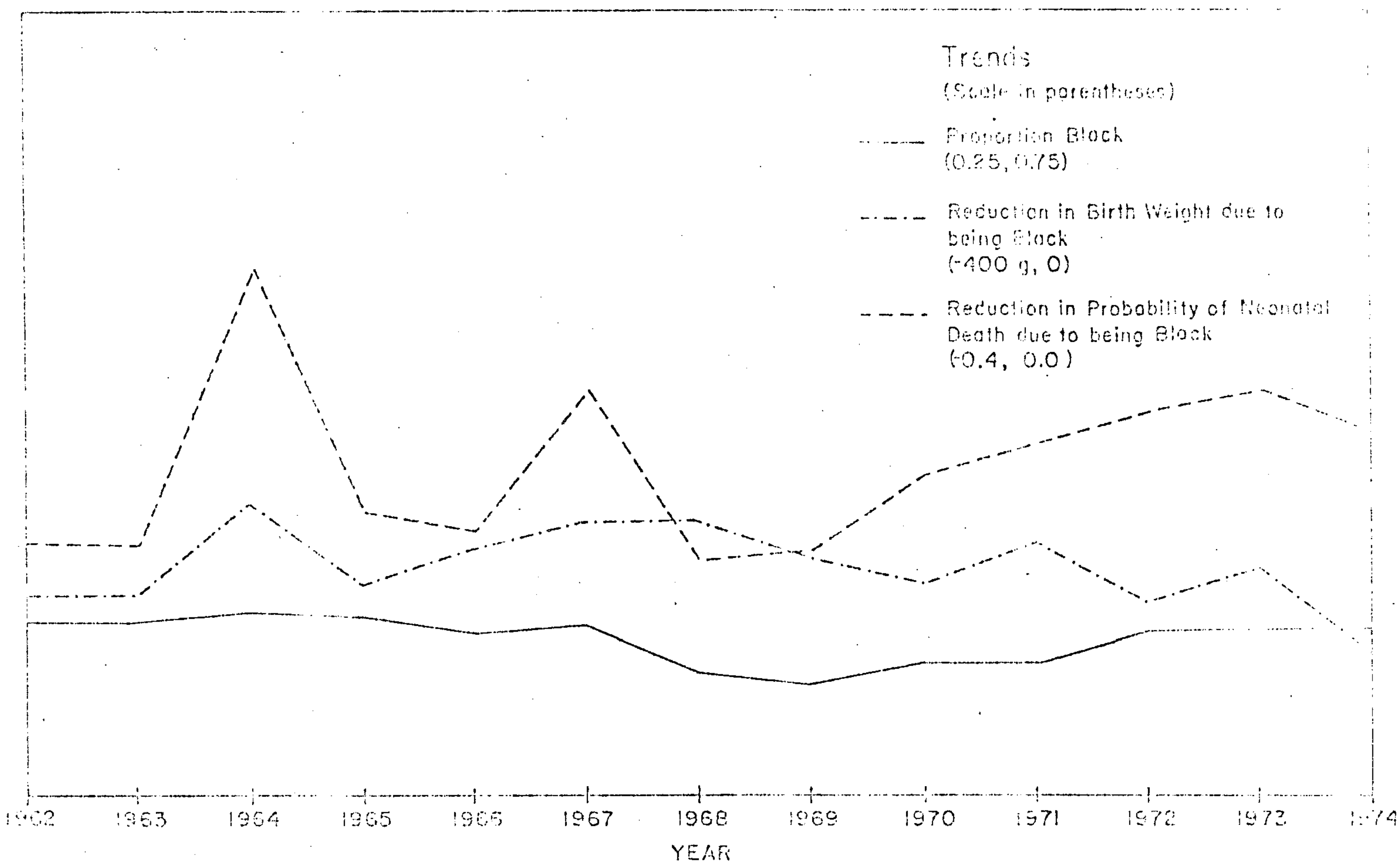
	YEAR						
	62	63	64	65	66	67	68
Intercept	1.29137509	1.27886785	1.19896739	1.30717943	1.27260408	1.23180297	1.23281239
Birth Weight	-0.00078516 (-85.55529)	-0.00076314 (-80.78564)	-0.00077225 (-83.09039)	-0.00080165 (-82.87345)	-0.00077946 (-80.71565)	-0.00079015 (-83.29729)	-0.00076193 (-75.66621)
Birth Weight Squared	0.00000012 (71.27892)	0.00000012 (67.05554)	0.00000012 (68.98217)	0.00000012 (68.63973)	0.00000012 (67.62684)	0.00000012 (69.17660)	0.00000012 (63.64231)
Race	-0.01861513 (-4.82624)	-0.02713249 (-6.87299)	-0.01291351 (-3.30822)	-0.02538165 (-6.24593)	-0.02635502 (-6.63174)	-0.01911346 (-4.81230)	-0.02782119 (-6.79239)
Sex	0.02130744 (7.04248)	0.02193627 (7.02110)	0.01901014 (6.12874)	0.02343642 (7.26150)	0.02125978 (6.65237)	0.02086642 (6.49362)	0.02186167 (6.71269)
Age of Mother	-0.00255430 (-1.28363)	-0.00419163 (-2.05485)	0.00213703 (1.05547	-0.00398568 (-1.94635)	-0.00348174 (-1.68792)	0.00071663 (0.32980)	-0.00219166 (-1.03530)
Age of Mother Squared	0.00002616 (0.73667)	0.00004818 (1.31518)	-0.00004105 (-1.12699)	0.00005922 (1.60896)	0.00003799 (1.01382)	-0.00003567 (-0.89544)	0.00001601 (0.41491)
Parity	0.00462307 (2.21829)	0.00985414 (4.70167)	-0.00125109 (-0.58770)	0.00503229 (2.25750)	0.00519946 (2.42071)	0.00589595 (2.46511)	0.00423837 (1.68401)
Parity Squared	-0.00031856 (-1.95162)	-0.00067512 (-4.21412)	0.00014317 (0.87397)	-0.00022335 (-1.29463)	-0.00024219 (-1.46958)	-0.00044308 (-2.23894)	-0.00011520 (-0.53130)
Legitimacy Status	-0.01342543 (-2.57283)	-0.01188559 (-2.20460)	-0.01116191 (-2.14638)	-0.01280023 (-2.39979)	-0.00278519 (-0.54306)	-0.00843391 (-1.64965)	-0.00455075 (-0.82739)
Previous Fetal Loss	0.00197349 (0.44072)	-0.00783498 (-1.67626)	0.00010075 (0.02136)	-0.00630607 (-1.30538)	-0.00682619 (-1.35736)	0.00505638 (0.98948)	-0.00313665 (-0.60369)
Birth in General Hospital	-0.03346367 (-5.23673)	-0.02921893 (-4.39668)	-0.01962164 (-2.83031)	-0.00963873 (-1.30423)	-0.02019186 (-2.50989)	-0.01945752 (-2.23438)	-0.02253747 (-2.12165)
R^2	0.3797	0.3585	0.3689	0.3894	0.3800	0.3989	0.3774
DF for Error	18465	18186	18081	16742	15924	15967	140[illegible]

(Continued)
REGRESSION COEFFICIENTS FOR NEONATAL MORTALITY MODEL (T-statistic in parentheses)

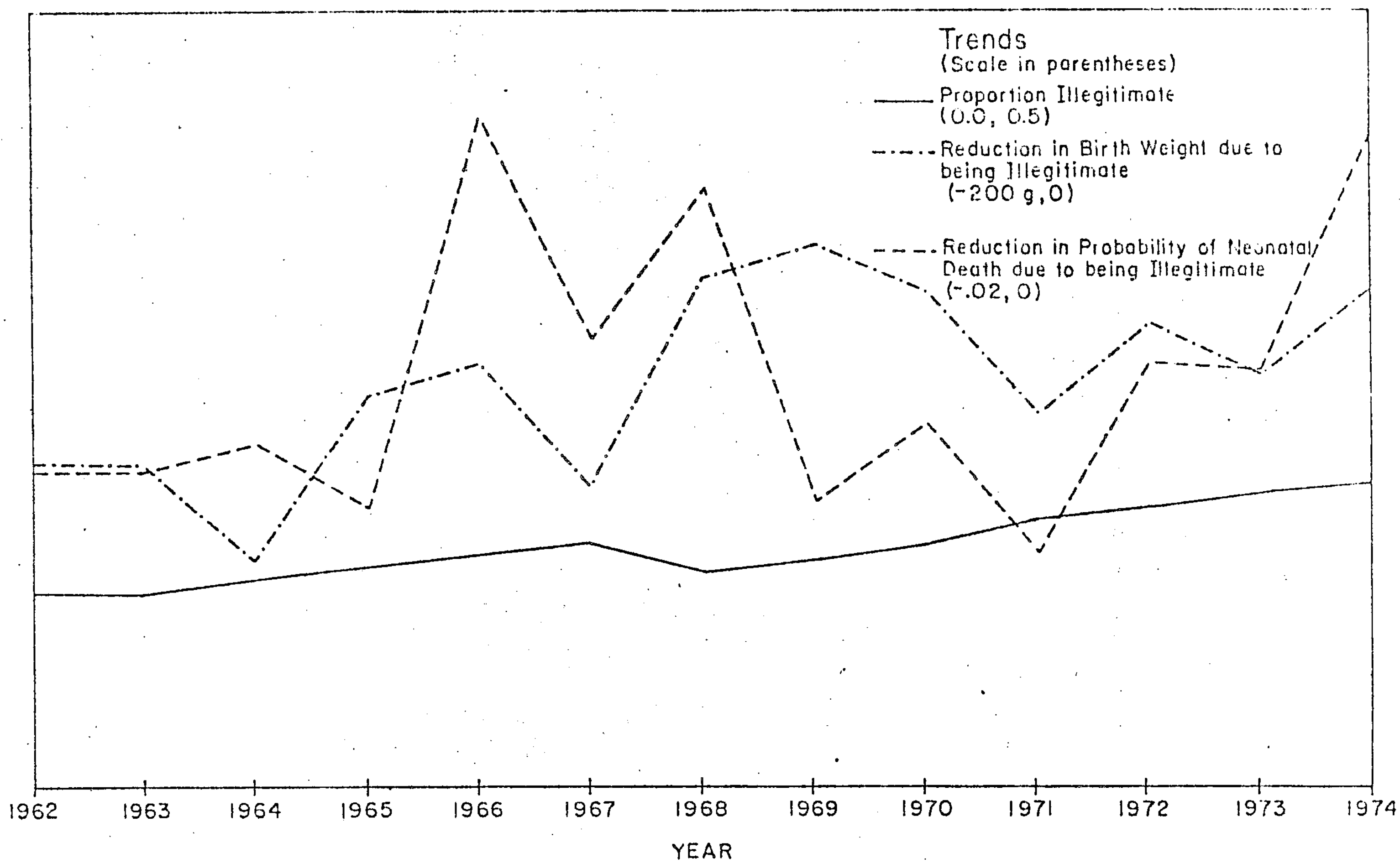
	YEAR					
	69	70	71	72	73	74
Intercept	1.31667301	1.23867038	1.15901243	1.15977127	1.11926561	1.15417825
Birth Weight	-0.00075352 (-75.73610)	-0.00075421 (-80.00879)	-0.00073214 (-77.59092)	-0.00075546 (-80.61960)	-0.00072777 (-76.29906)	-0.00071511 (-77.96330)
Birth Weight Squared	0.00000012 (63.92345)	0.00000012 (67.15422)	0.00000011 (65.43857)	0.00000012 (67.88091)	0.00000011 (63.98136)	0.00000011 (65.94230)
Race	-0.02729196 (-6.85079)	-0.02339102 (-6.01124)	-0.02183454 (-5.62698)	-0.02018712 (-5.16039)	-0.01904170 (-4.77622)	-0.02121246 (-5.44671)
Sex	0.01539694 (4.88107)	0.02043727 (6.52754)	0.01275232 (4.13518)	0.01302200 (4.12948)	0.01440595 (4.47025)	0.01163738 (3.71203)
Age of Mother	-0.00760556 (-3.62235)	-0.00075063 (-0.34253)	0.00050283 (0.23580)	0.00144885 (0.67228)	0.00315201 (1.40947)	-0.00144974 (-0.66465)
Age of Mother Squared	0.00012410 (3.22066)	-0.00000960 (-0.23411)	-0.00003479 (-0.87127)	-0.00003924 (-0.96653)	-0.00007456 (-1.74285)	0.00002185 (0.52330)
Parity	0.00459576 (1.85583)	0.00394013 (1.65650)	0.00600059 (2.37506)	0.00157503 (0.56586)	0.00734434 (2.65282)	0.00303410 (1.05263)
Parity Squared	-0.00051795 (-2.42856)	-0.00033226 (-1.60977)	-0.00031645 (-1.38803)	0.00008585 (0.31544)	-0.00063552 (-2.43393)	-0.00033582 (-1.12545)
Legitimacy Status	-0.01262321 (-2.39482)	-0.01059619 (-2.08888)	-0.01394887 (-2.77744)	-0.00901012 (-1.79620)	-0.00925527 (-1.84801)	-0.00322109 (-0.66457)
Previous Fetal Loss	0.00334998 (0.66225)	-0.00607501 (-1.21331)	-0.00120201 (-0.24498)	-0.00161891 (-0.32357)	0.00309934 (0.59566)	-0.00292275 (-0.58515)
Birth in General Hospital	-0.03876497 (-3.37049)	-0.05129895 (-4.18473)	-0.02158304 (-1.64265)	-0.04223760 (-3.10472)	-0.03246759 (-2.32096)	-0.04111585 (-2.69340)
R^2	0.3725	0.3760	0.3663	0.3914	0.3807	0.3929
DF for Error	14491	15890	15312	14817	14008	13457



Observed and Estimated Neonatal Deaths Per 100 Live Births,
North Carolina Sample, 1962-1974



Trends in Racial Composition and Effect of Race on Birth Weight and Neonatal Mortality, North Carolina Sample, 1962–1974



Trends in Illegitimacy and Effect on Birth Weight and Neonatal Mortality, North Carolina Sample, 1962-1974