Association of weight-length ratio at birth with psychomotor trajectories among preschool-aged children

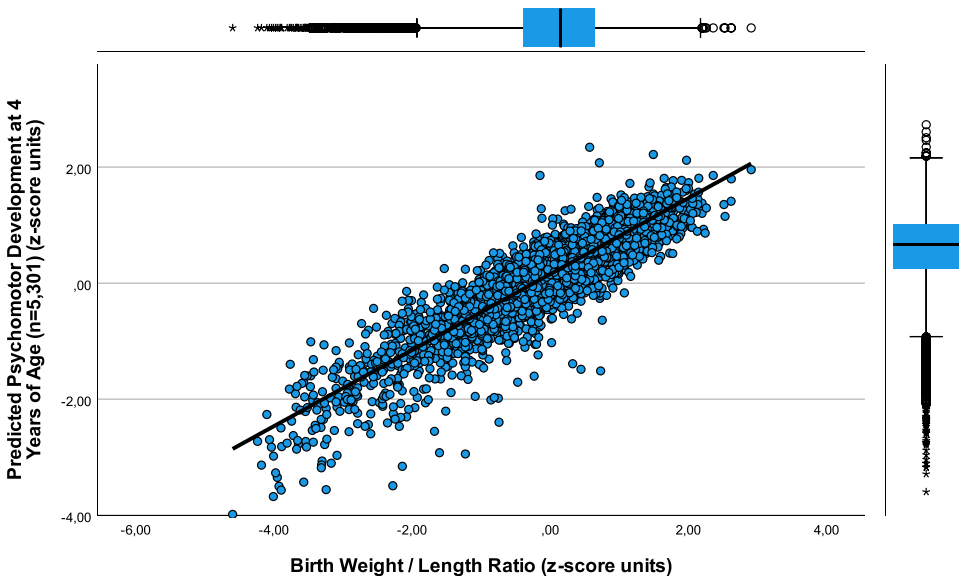
OBJECTIVE: School performance and educational success largely depend on intact brain function and are at risk when brain damage, developmental delay, or cerebral palsy occur. Prediction of developmental trajectories may therefore serve as a basis for early intervention strategies to improve educational success of children in a timely manner. To explore the predictive capacity of growth variables taken at birth to estimate developmental performance at preschool age, we examined predicted total psychomotor development score (pTPMDS) in a large prospective cohort.

STUDY DESIGN: A prospective cranial ultrasound screening (CUS) study was carried out in a level III perinatal center on 5799 live-born infants (January 1, 1984−December 31, 1988) at discharge of the mother after 5 to 8 days, of whom 498 (8.6%) left early (ie, at ≤4 days).[1] Hence, 5301 (91.4%) neonates (51.0% male) underwent CUS. In a previous study (1982−1986) from the same center, 137 (2.4%) newborns both underwent CUS and were evaluated for psychomotor development (PMD) (ie, intelligence quotient [IQ], Maze test [MT], and neurologic examination optimality score [NOS]) at 4 years of age.[2,3] The study was approved by the local institutional review board. This report follows the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) reporting guideline for observational studies.
We related the z-score (z) quotients of newborns' body weight (g)/total body length (cm, crown−heel), that is, the weight-length ratio (W/L), to pTPMDS (zpTPMDS=zpIQ+zpMT +zpNOS)/3) using linear regression analysis, receiver operating characteristics (ROC), and positive (PPV) and negative (NPV) predictive values for predicting adverse outcomes at preschool age (Supplementary material).

RESULTS: The 5301 newborns, including 571 (10.8%) of those born preterm (≤36 weeks' gestation), had the following characteristics: mean gestational age of 39.2 weeks (standard deviation [SD], 2.6; range, 24−43), weight of 3231 g (SD, 686; range, 350−5370), total body length of 50.5 cm (SD, 3.8; range, 25−61), head circumference of 34.4 cm (SD, 2.2; range, 21−43), Apgar score at 10 minutes ≤9 (480/5301; range, 2 −9), and umbilical arterial pH of 7.28 (SD, 0.07; range, 6.65 −7.83). Mean zpTPMDS was 0.17 (SD, 0.7; range, −4.0 to 2.3) and zW/L was 0.02 (SD, 1.0; range, −4.6 to 2.9).
The key result of our study is the observation that simple morphometric measures from newborns at birth such as W/L predict overall PMD at 4.3 (SD, 0.8) years of age. PMD was assessed by pTPMDS and related to W/L ratio in linear regression (zpTPMDS=0.166+0.647 × zW/L; r=0.892; n=5201; $P<.001$) (Figure) and ROC curve analyses (86.4% sensitivity, 81.0% specificity; area under the curve, 0.921; $P<.001$). PPV and NPV were 84.6% and 83%, respectively. Of note, small W/L ratios (eg, mean, −1.7 SD of zW/L=−2.3 [SD, 0.9; n=341]) resulted from prematurity and/or growth retardation (GR), yielding poor PMD (zpTPMDS=−1.7; SD, 0.6; n=341). Interestingly, among these 16 of 341 (4.7%) newborns, none presented with prematurity or GR before birth.

CONCLUSION: On the basis of complete obstetrical records of 5301 newborns, this prospective study demonstrated that simple growth variables at birth bear predictive capacity for PMD at preschool age.[2] The rationale for using W/L to estimate future PMD is its relation to both prematurity and asymmetric GR of the newborn (eg, when intrauterine oxygen is at short supply), 2 prime risk factors for poor neurocognitive performance.[2] This is important clinically because developmental trajectories can be estimated already at birth for further examinations, for example by imaging techniques or neurologic assessment even if delivery was uneventful and the infant born seemingly healthy. This would open a new avenue for early intervention strategies, timely rehabilitation, or even recently developed cell therapies.[4] In addition, the children at risk would profit from high plasticity of the infantile human brain to better overcome developmental shortcomings.[5] To account for medical care standards in rural areas and/or developing countries where cranial ultrasound availability is scarce, we propose the use of W/L. ■

FIGURE
Relation between pTPMDS and W/L at birth



A prospective CUS study was carried out on 5301 live-born infants (1984−1988) at discharge of the mother (after 5−8 days) from a level III perinatal center at the University of Giessen, Germany.[1] The correlation between predicted total psychomotor development score (pTPMDS) (z-score units) and the weight-length ratio (W/L) (z-score units) in 5301 newborns is depicted (zpTPMDS=0.166+0.647 × zW/L; r=0.892; n=5201; P<.001). The pTPMDS represents the average of predicted intelligence quotient (IQ), Maze test (MT), and neurologic examination optimality score (NOS) at 4.3 (standard deviation, 0.8) years of age (zpTPMDS=[zpIQ+zpMT result+zpNOS]/3) derived from stepwise multiple regression analyses from a previous study (pTPMDS=−17.87+0.00043 × Weight−0.501 × WMD_present+2.278 × pH_umb.art+0.177 × mode of delivery; r=0.637; n=129; P<.001).[2] The rationale behind the extrapolation of pTPMDS from children in whom psychomotor development was measured (n=130) to all 5301 cases of the CUS was firstly that these children underwent CUS in the same unit with identical obstetrical management. Secondly, the stepwise multiple regression showed a close relation between the variables (r=0.637), and finally, the pTPMDS was closely related to the summary z-score of the measured results of IQ, MT, and NOS testing (mTPMDS) (r=598; n=130; P<.001).[2] Of note, W/L at birth allows for estimation of psychomotor development at preschool age. This is clinically relevant because a small W/L is related to prematurity and asymmetric growth retardation, both of which are risk factors for poor neurocognitive development.

CUS, cranial ultrasound screening; *pTPMDS*, predicted total psychomotor development score; *W/L*, weight-length ratio.

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