

APPLE Study Protocol: Post-market Validation of the PreemieTest® Device for Neonatal Screening in Diverse Birth Scenarios – A Multicenter, Prospective Cohort Study

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Abstract

Background: Reliable assessment of post-natal gestational age (GA) remains a significant gap in resource-poor settings, where early obstetric ultrasound (US) is often unavailable or unreliable. Because fetal skin maturation follows a sigmoid trajectory that alters optical properties near term, noninvasive skin reflectance can serve as an indicator of GA, which can help in stratifying early respiratory risk.

Objective: To report a protocol designed to validate in a real scenario a portable optoelectronic device (PreemieTest®), which estimates GA within 24 to 48 hours after birth, and examines its association with respiratory outcomes at birth, 3 months, and 6 months.

Method and analysis: The APPLE Study is a multicenter prospective cohort study in Brazil and Honduras. We will compare the GA estimated by the PreemieTest® device with traditional approaches, such as gold-standard first-trimester US (when available), date of last menstrual period (LMP), and a postnatal clinical score, using correlation, Bland-Altman plots, and concordance analyses. We will be modeling with respiratory outcomes (hospitalizations, clinical diagnoses, and use of ventilatory support) with multivariable logistic regression adjusted for prespecified confounders (birth weight, sex, prematurity, mode of delivery, and US-based GA, considering clustering by location). Usability will be measured with the System Usability Scale among midwives. Data will be captured in Research Electronic Data Capture (REDCap) with standardized quality checks and monitored for completeness. Missing data will be addressed through multiple imputations and sensitivity analyses.

Discussion: This study will provide real-world evidence on the accuracy and clinical utility of a portable, low-cost optical approach for GA assessment in diverse birth settings, including remote communities in the Amazon. By clarifying performance across different phototypes and levels of care, and evaluating usability, the APPLE study aims to inform implementation pathways that promote equitable neonatal care in settings where dating uncertainty compromises early clinical decisions.

Trial Registration: Registered in the Brazilian Clinical Trials Registry, section of Observational Studies (Brazilian Clinical Trials Registry (ReBEC) — RBR-10ch623r, registered on April 24, 2024; UTN U1111-1302-9740). Ethical approval was obtained prior to the initiation of the study in both Brazil and Honduras.

Background

The definition of full-term newborn has been refined over the years. According to the World Health Organization (WHO), term newborns are delivered between 37 weeks and 0 days and 41 weeks and 6 days of gestation [1]. The American College of Obstetricians and Gynecologists (ACOG) further refine this classification, stratifying them into early term (37 0/7–38 6/7 weeks), full term (39 0/7–40 6/7 weeks), late term (41 0/7–41 6/7 weeks), and postterm (≥ 42 0/7 weeks) [2]. This stratification reflects growing evidence that neonatal morbidity varies substantially within the term range, particularly for outcomes such as respiratory distress syndrome, neonatal intensive care unit (NICU) admission, and

feeding difficulties [2]. Based on this, accurately determining the gestational age (GA) is crucial for guiding timely and appropriate neonatal interventions [3].

With continuing evidence that preterm babies have poorer outcomes compared to those born full-term, it is critical to estimate GA accurately. However, accurately estimating GA, whether during prenatal care or immediately after birth, remains a challenge. In low- and middle-income countries, limitations such as restricted access to healthcare professionals and services, lack of reliable data on gestational timing, high costs, and the potential inaccuracy of both clinical assessments and antenatal ultrasound (US) can compromise critical health decisions made at birth [3].

Currently, first-trimester US, particularly crown-rump length measurements up to 13 6/7 weeks, has been considered the gold standard for GA estimation [4]. Its margin of error is ± 5 to 7 days. [5] However, there is evidence that the use of US is not associated with a reduction in maternal, perinatal, or neonatal mortality [6]. Additionally, in many low- and middle-income countries, limited access to skilled professionals, inadequate infrastructure, and logistical constraints often result in the absence of early US data at the time of delivery. In these settings, the date of the last menstrual period (LMP) remains a widely used method [7].

Determining the first day of the LMP has been the first step in setting the expected delivery date. By convention, this date is 280 days after the first day of the last menstruation [2]. However, it is prone to systematic error due to recall bias, irregular menstrual cycles, hormonal contraceptive use, and uncertainty regarding actual menstrual bleeding episodes. Extensive cohort studies, such as those by Savitz et al., have demonstrated that estimates based on LMP tend to overestimate GA compared with those obtained from first-trimester US, thereby inflating preterm birth rates [8]. Although combining LMP with early US, with adjustment when discrepancies exceed 10 days, improves the accuracy of dating and assessment of perinatal outcomes [8], in some contexts, neither of these estimates is possible or reliable.

When reliable prenatal data are unavailable, post-natal clinical scoring (PCS) methods, such as the Capurro or Ballard scores, or anthropometric measurements, such as foot length, gain prominence. However, a recent systematic review with meta-analysis reported that these methods exhibit variable diagnostic accuracy, are highly dependent on examiner experience, and are inferior to early US [9].

Therefore, low-cost technological innovations that do not require specialists or expensive and complex training can contribute to equity in neonatal care, especially in resource-limited settings where diagnostic gaps directly impact newborn survival and quality of life.

Previous evidence indicates a strong correlation between skin reflectance and GA, regardless of the newborn's weight, sex, or skin phototype [10]. Between 22 and 40 weeks of gestation, the stratum corneum undergoes progressive maturation, improving the skin barrier function, thermoregulation, and protection against dehydration and injury [10]. These structural changes alter the optical properties of the skin, which can be assessed noninvasively through light reflectance [10] [11] [12] [13] [14].

The PremieTest®, a portable, noninvasive optoelectronic device, uses photobiological models and artificial intelligence, calibrated with early US, to estimate GA at birth and aid in stratifying neonatal respiratory risk [11] [12] [13] [14].

This paper outlines the APPLE study, a multicenter, prospective cohort study conducted in real-life settings, including remote Amazonian communities and urban centers.

Objectives

The APPLE study aims to investigate whether skin reflectance and GA, as estimated by the PremieTest®, are associated with respiratory complications at birth, at 3 months, and at 6 months postpartum. In addition, the study aims to evaluate the correlation between these measurements and traditional GA dating methods, such as early obstetric US, LMP, and PCS. Moreover, to assess the influence of PremieTest® on clinical decisions, we will conduct interviews with device users and use the System Usability Scale (SUS) questionnaire to measure the perceived usability of the equipment.

Methods

Study Design

A multicenter, international prospective cohort study linked to the APPLE study consortium, conducted in four centers in Brazil and one in Honduras. The APPLE study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Plausibility and hypothesis

Skin development begins in early pregnancy, during the first trimester, and progresses gradually throughout gestation [15]. The stratum corneum is fully formed by 34 weeks of gestational age. At birth, full-term newborns have a well-defined stratum corneum; however, this layer continues to mature gradually over time, ultimately resulting in fully competent adult skin [14]. In contrast, preterm newborns exhibit underdeveloped skin function, which typically does not reach levels comparable to full-term infants until at least 2–3 weeks after birth. These biochemical and structural changes (e.g., vernix composition and amino acid profile) plausibly affect scattering and absorption at the skin surface, supporting the use of reflectance to track postnatal maturity [16].

Interestingly, the development of the fetal lungs and skin appears to follow closely related biological timelines, particularly in the final trimester of pregnancy. Around the same gestational window when pulmonary surfactant production begins to stabilize, the skin undergoes significant structural changes, including the formation and maturation of the stratum corneum. This parallel progression suggests that surface properties of the skin at birth may indirectly reflect the degree of pulmonary maturity [14].

Previous evidence has demonstrated a consistent association between skin optical properties and GA, with correlations unaffected by sex, weight, or skin pigmentation [14].

We hypothesized that estimating GA using the PreemieTest® in the first 48 hours after birth could serve as a noninvasive and practical indicator of GA, correlating with adverse respiratory outcomes in the first months of life. In settings where accurate prenatal dating is unavailable or uncertain, a frequent challenge in many low-resource contexts, these measurements provide critical guidance for early clinical decision-making. Furthermore, they can help identify newborns at increased risk of complications, such as respiratory distress syndrome (RDS), serving as a valuable complementary tool for early post-natal risk stratification [14].

Study setting

The APPLE study is underway in 4 of the five regions of Brazil, in states with distinct geographic and socioeconomic contexts: Amazonas (North), Rio Grande do Norte (Northeast), Mato Grosso do Sul (Central-West), and Minas Gerais (Southeast). The study is also conducted in Honduras (Figure 1). Participating sites include hospitals with high-risk maternity services, natural birth centers, and home birth centers.

Recruitment and follow-up occur in both urban and rural areas, including remote regions of the Amazon. Participating institutions in Brazil include: 1) In the state of Amazonas, Balbina Mestrinho Maternity and Ana Braga Maternity in the municipality of Manaus; Vó Mundoca Hospital in the riverside and remote municipality of Borba; and Edith Mendes Weckner Hospital in the riverside and remote municipality of Novo Aripuanã; 2) in the state of Minas Gerais, Sofia Feldman Hospital; 3) in the state of Mato Grosso do Sul, Maria Aparecida Pedrossian University Hospital and Florescer Humanized Birth Center; and 4) in the state of Rio Grande do Norte, Januário Cicco Maternity School, and Ana Bezerra University Hospital. In Honduras, Hospital Escuela (HE), **Instituto Hondureño de Seguridad Social** (IHSS) and Hospital General San Felipe (HGSF). There are also birth centers, as well as riverside and remote communities.

Eligibility criteria

All inclusion criteria are newborns whose parents agree to participate in the study. Exclusion criteria include congenital malformations or structural skin abnormalities, as well as skin conditions that may interfere with reflectance (e.g., anhydramnios, hydrops fetalis, congenital skin disorders, chorioamnionitis).

Sample size, intraclass correlation coefficient, and design effect

The sample size was calculated using STATA. The primary endpoint is respiratory morbidity within 6 months of life (yes/no). We assumed a baseline event rate of 15% in the low-risk group ($p_0 = 0.15$), an odds ratio (OR) of 2.0 for the association with the PreemieTest® high-risk classification, and a 50% prevalence of high-risk newborns. Under these assumptions, the expected event rate in the high-risk group is 26%, yielding an overall event rate of approximately 20%.

We set the type I error (α) at 0.05 (two-sided) and the type II error (β) at 0.20, corresponding to 80% statistical power. A simple two-proportions test would require approximately 415 participants. However,

because the primary analysis will use multivariable logistic regression, we applied the events-per-variable (EPV) rule with a conservative threshold of 20 EPV for 10 predictors. This required at least 200 events, which, with a 20% event rate, correspond to 974 participants before adjusting for clustering.

Given the multicenter design (five sites: Amazonas, Minas Gerais, Mato Grosso do Sul, Rio Grande do Norte, and Honduras), we incorporated a design effect (DEFF) to account for within-site correlation, assuming an average of $m = 150$ neonates per site-wave (analytic stratum) and intraclass correlation coefficient (ICC) = 0.01:

$$DEFF = 1 + (m - 1) \times ICC = 1 + (150 - 1) \times 0.01 = 2.49$$

Here, m denotes the average adequate cluster size per analytic stratum (i.e., per site and time-block/wave), rather than the total number enrolled per site. This reflects how the primary analysis will be conducted (by period or stratum) and provides a conservative inflation rate while maintaining feasibility. Multiplying the pre-clustering sample size by the DEFF yields $974 \times 2.49 \approx 2,426$ participants. Allowing approximately 15% attrition/missingness gives a target total of nearly 2,900, aligned with our planned enrollment (~580 per site).

Although the overall planned enrollment per site is ~580, the primary analysis will employ mixed-effects models (logistic regression with a random intercept for site and robust standard errors clustered at the site, with optional random effects for site $\times$ wave as needed). This modeling approach directly accounts for clustering and typically reduces reliance on DEFF-based inflation. We therefore retain $DEFF = 2.49$ for transparent planning and conservatism. We will report a post-hoc design effect (and intra-class correlation) from the realized data to document the actual clustering observed. As a robustness check, sensitivity analyses will repeat the primary models without DEFF-based inflation (i.e., using the realized sample with mixed-effects modeling only) to verify that conclusions are consistent.

Recruitment

The recruitment process is ongoing during prenatal visits, delivery, or early post-natal hospitalization. Mothers or legal guardians will receive information about the study and be asked to sign informed consent forms. Recruitment of birth attendants (physicians, nurses, doulas, physiotherapists, and midwives) will occur prior to delivery, with training on the use of the device. For homebirths, recruitment will be facilitated through prenatal contact with midwives and doulas.

Outcomes

Primary outcome. The primary outcome is respiratory morbidity within 6 months of life (yes/no), defined from medical records (hospitalizations, bronchiolitis, pneumonia, respiratory distress syndrome, or need for ventilatory support/oxygen therapy). The key exposure is the PremieTest®-derived risk classification (high vs. low) or a prespecified reflectance-based risk score. Associations will be assessed using multivariable logistic regression.

Secondary outcomes. (a) Agreement and correlation between skin reflectance–based GA estimates and reference standards (ultrasound, last menstrual period, or postnatal clinical score when available), using Bland–Altman plots, correlation coefficients, and mean absolute error (MAE); (b) usability of the PremieTest® as reported by birth attendants; and (c) the impact of the device on clinical decision-making at birth.

Data collection methods, management, and monitoring

Data collection commenced in March 2024 and is anticipated to continue through March 2026. The ongoing data collection process is as follows at three main time points: at birth (within 24 to 48 hours), including GA estimation using the PremieTest®, and by the LMP, US, and by the PCS methods, when available (Figure 2).

Additionally, the data includes demographic, maternal, newborn clinical, and socioeconomic data, as well as a usability questionnaire. During follow-up (at 3 and 6 months), information on respiratory outcomes and hospitalizations will be collected through scheduled telephone interviews, in-person appointments, and review of pediatric and hospital records. The principal investigator (R.L.G.) is responsible for monitoring the data and ensuring that the researchers involved in the study conduct the research in accordance with the protocol. This includes verifying that the study is conducted within timelines and budget, and in compliance with ethical standards. We systematically conduct quality audits, training, and calibration for evaluators to ensure consistency and accuracy. All data will be entered into a secure, access-controlled electronic database (REDCap).

Due to legal and ethical restrictions related to personal data protection (LGPD), the individual-level dataset cannot be publicly shared. A de-identified, minimal dataset sufficient to reproduce the main findings, plus the data dictionary and code, will be made available upon reasonable request to the corresponding author, contingent on data use agreement and ethics approval. Metadata (data dictionary, study instruments) will be provided as Supplementary files.

Device/measurement

Device description. The PremieTest® is a portable, noninvasive optoelectronic device that emits and detects reflected light from the neonatal skin to estimate GA using a calibrated algorithm trained against first-trimester US. The equipment also provides the probability (%) of the newborn requiring intensive care unit (ICU) care, ventilatory support, and developing RDS. The probe is contact, low-intensity, and battery-power; no ionizing radiation is involved (Figure 3).

Measurement site and timing. Measurements are obtained within 24–48 h after birth at the plantar surface (sole) of one foot. If contraindicated at that site (e.g., dressings), the contralateral foot is used.

Skin preparation. Before measurement, visible vernix and moisture are gently removed with sterile gauze; the skin is left clean and dry for ~30–60 s. Any creams or emollients applied in the previous hour are recorded.

Ambient light and position. Measurements are taken indoors, away from direct sunlight or intense overhead lighting. The infant rests in the supine position with the foot supported; the operator shields the probe with the hand if needed to minimize stray light.

Acquisition procedure. The probe is placed perpendicularly to the skin with gentle, uniform contact. The device records three consecutive readings (each ≥ 3 s); the software returns a single GA estimate as the median/quality-controlled average. If any read fails the built-in quality check, it is repeated.

Infection prevention. The probe tip is disinfected between participants with 70% isopropyl alcohol (contact time of at least 30 seconds) and then dried with sterile gauze; no shared gels are used.

Usability. After training and supervised use, birth attendants complete the SUS and a brief semi-structured interview on acceptability/feasibility.

Adverse events. Given the noninvasive, low-energy optical nature of the device, no device-related adverse events are expected. Any skin erythema, intolerance, or device malfunction is recorded and reported to the coordinating center.

Statistical analysis

Descriptive statistics will be used to summarize the characteristics of the newborn cohort. Categorical variables will be presented as frequencies and percentages, and continuous variables will be reported as means and standard deviations or medians and interquartile ranges, depending on data distribution. Normality will be assessed using the Shapiro-Wilk test.

To investigate whether skin reflectance and GA estimated by the PremieTest® are associated with respiratory complications at birth, 3 months, and 6 months postpartum, comparisons will be conducted using the Chi-square or Fisher's exact test for categorical variables and the Mann-Whitney U test or Student's t-test for continuous variables.

Multivariable logistic regression models will be used to assess the independent association between skin reflectance and respiratory complications. Separate models will be developed for outcomes at birth, 3 months, and 6 months. The primary predictors will be skin reflectance and GA estimated by PremieTest®. Models will be adjusted for potential confounding factors, including birth weight, sex, prematurity status, delivery mode, and GA estimated by early obstetric ultrasound. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) will be reported.

To evaluate the agreement between the GA estimated by the PremieTest® and traditional GA dating methods (early US, LMP, and the PCS), we will use Spearman's rank correlation coefficient or Pearson's correlation coefficient, depending on the data distribution. Correlations between skin reflectance and GA obtained from each method will also be assessed. Correlation strength will be interpreted as follows: < 0.3 (weak), $0.3-0.5$ (moderate), and > 0.5 (strong).

Additionally, scatter plots will be generated to visualize the relationships between methods, and Bland-Altman plots will be used to evaluate agreement between the PreemieTest® and each traditional GA estimation method.

Missing data will be handled using appropriate imputation methods or sensitivity analysis, depending on the mechanism of missingness.

All analyses will be conducted using R (R Foundation for Statistical Computing, Vienna, Austria) or STATA (StataCorp, College Station, TX), with a two-sided significance level of $p < 0.05$.

Patient and Public Involvement

As this is a comprehensive study involving four universities, several hospitals, birth centers, and even riverside and remote communities, public education on the topic was conducted both before and during the project's implementation through various lectures and workshops on the subject. Due to the nature of the study, patients were not involved in the planning phase; however, the perspectives of mothers and healthcare professionals have been considered in the dissemination plans. Hospitals, healthcare professionals, and participants receive information related to the study through an explanation of the protocol and the signing of the informed consent form.

Ethics and dissemination

Ethical approval was obtained before the start of the project by the Ethical Committee on Human Research of the Federal University of Amazonas, main center, and the Autonomous University of Honduras (CAAE: 73824523.0.1001.5020, opinion: 6.437.242; IRB00003070) and registered with the Brazilian Clinical Trials Registry (ReBEC — RBR-10ch623r, registered on April 24, 2024, section of observational studies under the protocol RBR-10ch623r, UTN number: U1111-1302-9740). Parents receive written and verbal information about the study. Written informed consent will be obtained from the parents of each participant prior to their participation.

The authors declare that they have no competing interests and are committed to maintaining data confidentiality, including secure storage for a minimum of five years. The study results will be published in scientific journals, in master's and doctoral theses, and presented at scientific conferences. To make our research more accessible to the public, the results will also be presented in health-related workshops and seminars, published in popular science journals and magazines on family and parenting, and released to the media (newspapers, radio, television, and social media).

Discussion

Determining GA with precision is fundamental to both obstetric and neonatal care, directly influencing maternal and child health outcomes [2]. Accurate dating supports appropriate prenatal planning, guides the timing and interpretation of antepartum tests, informs assessment of fetal growth, and underpins strategies to prevent preterm and post-term births along with their associated complications.

Although early antenatal US is the most accurate method for estimating GA, it is not accessible in all settings, and few initiatives are underway to address this public health problem. Therefore, soft technologies that can deliver reliable, rapid, and low-cost results can help promote health equity and reduce preventable neonatal morbidity and mortality in low- and middle-income countries.

Trial status

Protocol version (October 20, 2023); recruitment began March 2024; anticipated completion March 2026.

Abbreviations

ACOG: American College of Obstetricians and Gynecologists (*Colégio Americano de Obstetras e Ginecologistas*)

APPLE: *Acompanhamento de Bebês pelo PreemieTest* (APPLE Study cohort)

CAAE: *Certificado de Apresentação para Apreciação Ética* (Brazilian ethics submission ID)

CAPES: *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (Brazilian Federal Agency for Support and Evaluation of Graduate Education)

DEFF: Design effect

CI: Confidence interval

CNPq: *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (National Council for Scientific and Technological Development)

EBSERH: *Empresa Brasileira de Serviços Hospitalares* (Brazilian Company of Hospital Services)

EPV: Events-per-variable

FAPEAM: *Fundação de Amparo à Pesquisa do Estado do Amazonas* (Amazonas Research Foundation)

FCM: *Facultad(e) de Ciencias Médicas* (Faculty of Medical Sciences)

GA: Gestational age

HE: *Hospital Escuela* (Teaching Hospital, Tegucigalpa, Honduras)

HGSF: *Hospital General San Felipe* (General Hospital San Felipe, Tegucigalpa, Honduras)

HUGV: *Hospital Universitário Getúlio Vargas* (Getúlio Vargas University Hospital)

HUGV/UFAM/EBSERH: *Hospital Universitário Getúlio Vargas da Universidade Federal do Amazonas, administrado pela EBSEH* (Getúlio Vargas University Hospital of UFAM, managed by EBSEH)

ICC: Intraclass Correlation Coefficient

ICU: Intensive Care Unit

IHSS: *Instituto Hondureño de Seguridad Social* (Honduran Institute of Social Security)

IRB: Institutional Review Board

LGPD: *Lei Geral de Proteção de Dados Pessoais* (Brazilian General Data Protection Law)

LMP: Last menstrual period

MAE: Mean absolute error

NICU: Neonatal intensive care unit

OR: Odds ratio

PCS: Post-natal Clinical Scoring (*post-natal clinical score*)

ReBEC: *Registro Brasileiro de Ensaios Clínicos* (Brazilian Clinical Trials Registry)

REDCap: Research Electronic Data Capture

RDS: Respiratory distress syndrome

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

SUS: System Usability Scale

UFAM: *Universidade Federal do Amazonas* (Federal University of Amazonas)

UFMS: *Universidade Federal de Mato Grosso do Sul* (Federal University of Mato Grosso do Sul)

UFRN: *Universidade Federal do Rio Grande do Norte* (Federal University of Rio Grande do Norte)

UNAH: *Universidad Nacional Autónoma de Honduras* (National Autonomous University of Honduras)

US: Ultrasound

UTN: Universal Trial Number

WHO: World Health Organization

Declarations

The APPLE study was approved by the research ethics committees at all participating sites: Federal University of Amazonas (UFAM - CAAE: 73824523.0.1001.5020; Federal University of Mato Grosso do Sul (UFMS – CAAE: 73824523.0.2001.0021; Sofia Feldman Hospital – CAAE: 73824523.0.2002.5132; UFRN – CAAE: 73824523.0.1001.5020; PPP.CAP.074; and the Institutional Review Board of the Universidad Nacional Autónoma de Honduras (UNAH IRB: IRB00003070). The study will be conducted in accordance with the Declaration of Helsinki and local regulations. Written informed consent will be obtained from parents or legal guardians prior to any study procedure for all participating newborns.

Consent for publication

Not applicable. All images are fully non-identifiable (no faces or unique features), and no individual-level details are reported, in line with BMC editorial policies. If any identifiable images or case details are included in future publications arising from this cohort, written consent for publication will be obtained from the parents or legal guardians of the individuals involved.

Availability of data and materials

De-identified participant-level data and the study protocol will be made available upon reasonable request to the corresponding author after publication of the primary results, subject to a data use agreement and in compliance with applicable privacy regulations. Data will not include any direct identifiers or information that could be used to re-identify participants or recruiting sites.

Competing interests

The authors declare that they have no competing interests. Birthtech® Dispositivos para a Saúde Ltda provided all study devices (PremieTest® units) as a donation/loan; the provider had no role in study design, data collection, analysis, interpretation, manuscript preparation, or the decision to submit.

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Authors' contributions

Conceptualization: R.L.G.; S.A.P.; D.S-M.; G.S.N.; L.I.Z.; A.L.M.

Methodology: R.L.G.; S.A.P.; D.S-M.; G.S.N.; A.L.M.; L.I.Z.

Protocol writing for ethics committees: R.L.G.; S.A.P.; D.S-M.; G.S.N.; A.L.M.; L.I.Z.; A.M.L.; E.E.; I.C.F.B.; H.M.C.C.

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Figures



Figure 1

Geographic distribution of the APPLE study.

Caption: The marks on the map represents the states in Brazil where the PreemieTest® will be used (Amazonas, Minas Gerais, Rio Grande do Norte, and Mato Grosso do Sul), as well as in Tegucigalpa, Honduras.



Figure 2

Recording PreemieTest® data.

Caption: Field photograph from a riverine community in Amazonas state, Brazil, taken during study activities.



Figure 3

Field measurement of neonatal skin reflectance at the sole of the feet using the PremieTest® device.

Caption: Riverine community in Amazonas state, Brazil. A community health worker uses the PremieTest® device in a home setting with a newborn delivered at home.