A longitudinal study of skin barrier function in pregnancy and the postnatal period

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Abstract

Background: It is unknown whether skin's barrier function changes in pregnancy. Trans Epidermal Water Loss (TEWL) refers to the total amount of water loss through the skin and TEWL can be measured non-invasively as an index of skin barrier function. We measured TEWL during and after pregnancy to evaluate pregnancy-related skin barrier function.

Methods: This was a prospective, longitudinal cohort study of 52 low-risk, first-time pregnant women nested within the Screening for Pregnancy Endpoints (SCOPE) Ireland study.

TEWL (g_{water}/m²/h) was measured three times during pregnancy: 19–21 weeks, 27–32 weeks and 36 weeks; and three times postnatally: 2–4 days, 2 months and 6 months post-delivery. Data were analysed using SPSS 18.0 and $P > 0.05$ was considered statistically significant.

Results: A rise in TEWL was seen between each visit with the highest readings, exceeding the normal range of 0–20 g_{water}/m²/h, recorded at two months post-delivery. Forty women attended at two months post-delivery of whom 22 women had an average reading between 0 and 20 g_{water}/m²/h; 10 women had an average reading between 21 and 40 g_{water}/m²/h and 8 women had an average reading between 41 and 75 g_{water}/m²/h. Readings had returned to an average of 0–20 g_{water}/m²/h at six months postnatally.

Conclusion: TEWL increases slightly in pregnancy and the postnatal period. The clinical significance of this is unclear and requires further investigation.

Keywords

Postnatal, pregnancy, skin barrier, trans epidermal water loss

Background

The skin serves as a primary defense mechanism providing protective functions such as ultraviolet (UV) protection, anti-oxidant and anti-microbial functions.¹ It is also a sensory organ and regulates body temperature. Skin is made up of two layers, the dermis and the epidermis, each with its own distinctive functions and features. The epidermis is the upper most layer of skin and it forms the waterproof protective wrap over the body's surface. This function is provided mostly by the uppermost layer of the epidermis – the stratum corneum. The stratum corneum is a resilient layer composed of corneocytes and intracellular lipids, which acts as the epidermal permeability barrier, controlling the transcutaneous movement of water and other electrolytes 'out' and transcutaneous movement 'in' of bacteria, viruses and other topically encountered organisms and compounds such as allergens, medications and creams.^{2,3} Recent research has found that the stratum corneum has a complex and intricate level of biological and chemical activity.³ When the permeability barrier is compromised, either by internal or external factors, this manifests in the skin as the clinical symptoms of irritation and inflammation.

Eczema is a superficial inflammatory process involving the epidermis. The precise aetiology of eczema is unknown, but temporal changes in prevalence point to the potential causal role of environmental factors.⁴ Eczema has a fluctuating course in most patients and can be influenced significantly by environmental and internal triggers.⁴

Eczema is the most common dermatosis of pregnancy. About 20–40% of women with atopic eruption have it prior to conception; the rest develop symptoms for the first time during pregnancy.² Of women with pre-existing eczema, approximately 25% improve and 50% experience deterioration in their skin condition during pregnancy.²

Recently, research studies have begun to suggest that defects in permeability function, such as irritation, are not secondary consequences but critical factors for various skin diseases. Skin barrier function can be measured non-invasively using a tewameter which measures trans epidermal water loss (TEWL). This non-invasive method enables the production of numerical data, which are objective,

reproducible and suitable for statistical processing. The performance of the Tewameter[®] TM 300 is a proven tool used in skin barrier assessment.^{5,8}

There is a paucity of literature describing skin barrier function in pregnancy. Indeed, a literature search conducted using Blackwell Synergy, Science Direct, Pubmed, Wiley Interscience and Google Scholar from January 1995 to September 2011 using the terms 'trans epidermal water loss (TEWL) and pregnancy', 'skin barrier function and pregnancy' and eczema and pregnancy revealed no primary research articles relating specifically to changes in skin barrier function in pregnancy.

We have recently published the largest data set of TEWL in neonates.¹ The aim of this maternal study was to establish skin barrier function during and after pregnancy using TEWL measurements.

Methods

This study was nested within the Screening for Pregnancy Endpoints (SCOPE) Ireland Study (www.scopestudy.net) based at Cork University Maternity Hospital (CUMH). SCOPE Ireland is an international, longitudinal, prospective cohort study, which recruited 1792 low-risk first time mothers attending CUMH for antenatal care from March 2008 to February 2011. Inclusion and exclusion criteria are outlined in McCowan et al.⁹

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For the purpose of this study, three more specific exclusion criteria were added:

- women with a history of eczema;

- women who were not attending CUMH for their antenatal care (to coincide antenatal visits with their clinic visits) and
- women who had not consented for BASELINE study (to allow completion of postnatal measurements).

Ethical approval was obtained from the Clinical Research Ethics Committee of the Cork Teaching Hospitals and all women provided informed written consent. Recruitment to this study began in June 2010 and data collection was completed in September 2011.

Due to the lack of literature in this field, it was not possible to establish an ideal sample size. However, previous dermatology observational studies of skin function typically include sample sizes of 30–60 patients.^{8,10,11} Therefore, we aimed to recruit 50 women. Women participating in SCOPE were approached at the time of the second visit (19+0–21+6 weeks' gestation). In total, 70 women were approached of whom 52 were eligible and agreed to take part.

In addition to the information obtained as part of the SCOPE study, described in detail elsewhere (www.scopestudy.net) and which included maternal age, smoking history, alcohol intake and BMI, a specific history of eczema, asthma and other atopy was elicited. All details and results were stored on a password secured excel database.

Six sets of measurements were carried out on each woman. The first measurement was taken at 19+0–21+6 weeks' gestation, the second at 27+0–32+6 weeks' gestation and the third at 36+6 weeks' gestation. The fourth measurement was carried out two to four days

Figure 1. Recruitment and attendance.

*Twenty-five women who attended each visit.

^Number of other women who attended each visit.

Table 1. Maternal characteristics.

Variable	N at first visit (%) (N = 52)
No history of asthma prenatally	47 (90.3%)
Age (years)	
19–25	10 (19.2%)
26–32	29 (55.7%)
33–39	13 (25%)
Did not smoke antenatally	50 (96.1%)
Did not consume alcohol antenatally	47 (90.3%)
BMI (value)	
18–24.9	35 (67.3%)
25–29.9	9 (17.3%)
30–37	8 (15.3%)

Figure 2. Timeline of results for each time point.

Figure 3. Median TEWL measurements for each visit.

post-delivery, the fifth at two months post-delivery and the sixth at six months post-delivery.

TEWL was measured using the tewameter (Tewameter® TM 300, Courage & Khazaka, Germany), which is based on the vapour pressure gradient estimation. Using this technique, it is possible to measure the invisible, yet steady evaporation of water from the epidermis. The open cylinder method consists of two moisture sensors coupled with temperature sensors inside a cylindrical probe that is placed on the skin. In this probe, the moisture sensor and temperature of the rising water vapour are measured. The TEWL rate is calculated as grams per square metre per hour ($\text{g}_{\text{water}}/\text{m}^2/\text{h}$). A reading of 0–20 $\text{g}_{\text{water}}/\text{m}^2/\text{h}$ is considered to be within the normal range.⁵

Investigations were carried out by a single researcher and in the same environmentally controlled room in Cork University Maternity Hospital from June 2010 to September 2011. An established Standard Operating Procedure for the measurement of TEWL was followed. In brief, a mean room temperature of 20–25°C and a mean relative humidity of 30–45% were maintained by means an air-conditioning unit. The probe was held in place on the volar surface of the arm for approximately 30 s until a steady TEWL value was established. The average of three consecutive measurements was recorded.

Five variables were examined for each visit: history of asthma, maternal age, smoking, alcohol consumption and BMI. Collected data were stored in a password-protected database. Participants were only identifiable by initials and SCOPE ID number. Data were analysed using SPSS 18.0. Descriptive statistics such as median was calculated for each variable.

Friedman's two-way analysis of variance by ranks was used to compare results of each visit and Mann–Whitney U Test was used to compare the influence of the variables asthma, smoking and alcohol consumption on TEWL. Maternal age and BMI were analysed using the Kruskal–Wallis one-way analysis of variance by ranks. $P > 0.05$ was considered statistically significant for both tests.

Results

Over the course of three months, 70 women were approached and 52 women consented and were recruited. Figure 1 shows the recruitment and attendance for each visit. Timeline graphs generated from the average monthly readings are shown in Figure 2. These graphs demonstrate TEWL measurements were relatively constant and not affected by the season, external environment or ambient temperature.

All women were of white European ethnicity. They ranged in age from 19 to 39 years with the mean age of 30 years. Sixteen women (30.7%) smoked prenatally and two (3.8%) antenatally. Forty-five women (86.5%) consumed alcohol prenatally and three (5.7%) antenatally. Five women (9.6%) had a history of asthma but none of them experienced an exacerbation of their symptoms during pregnancy. Maternal characteristics are summarised in Table 1.

Twenty-five women had a complete set of six measurements taken. Sixteen women had five sets of measurements taken and seven women had four sets taken.

TEWL was independent of maternal age, history of asthma, smoking alcohol intake and BMI.

Clinically, there was a non-significant rise in TEWL from the first measurement at 19+0–21+6 weeks' gestation to the fifth visit at two months post-delivery. Despite this steady rise, measurements remained within the normal range of 0–20 $\text{g}_{\text{water}}/\text{m}^2/\text{h}$ antenatally and in the immediate post-partum period only rising above the normal range at two months post-delivery. By the sixth post-natal month, TEWL has decreased back to the same level observed in the mid-trimester. Median TEWL measurements are represented on a box plot in Figure 3.

Using the non-parametric test for related variables, a statistically significant difference is seen between each visit ($P > 0.05$). However, because the measurements remain within the normal range, except for two months postnatally, this statistical difference may not have clinical significance.

Conclusion

The aim of this study was to establish whether skin barrier function, as measured by TEWL, is affected by pregnancy. Overall, there was a statistically significant increase in TEWL as pregnancy progressed. However, in the antenatal period, the readings remained within normal limits and the observed increase in TEWL is felt unlikely to be clinically significant. At two months post-partum, average TEWL rose above previously reported normal limits. It is difficult to explain this brief but significant rise in TEWL. One possibility is that adaptation to the non-pregnant state may in some way drive up water loss through the skin. Alternatively, these women were all first-time mothers learning to cope with the physical and psychological stresses of motherhood. In contrast, Altemus found that psychological stress and sleep deprivation had no effect on TEWL in healthy skin in adult females, who were not pregnant or nursing newborn babies.¹⁰ The readings had returned to normal at six months postnatally, in line with the re-establishment of non-pregnant physiologic homeostasis.

There is widespread interest in the anatomy and physiology of unhealthy skin in both adults and infants but very little primary research into the structure and function of 'healthy' adult skin. In general, previous research studies include adults with healthy skin as control groups⁸ or in randomised trials of interventions.^{11,12} There is a paucity of data concerning healthy adult skin and how it can be affected by normal but physiologically challenging events such as pregnancy. Indeed, there is no primary research into skin barrier function in pregnancy in women with healthy skin. Previous studies investigating the skin in pregnancy are largely retrospective and included women with pre-existing skin conditions.^{12,13}

In conclusion, this is the first investigation of skin barrier function as assessed by TEWL in pregnancy. This unique observational study of healthy skin found that TEWL increases slightly during pregnancy but that largely the skin barrier remained clinically stable over a 11-month period of high hormonal activity. The significance and the cause of the rise in TEWL at two-month post-partum time point are unclear and require further investigation.

Declaration of conflicting interests

Nil

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Ethical approval

This was obtained from the Clinical Research Ethics Committee of the Cork Teaching Hospitals.

Consent

The participants were given an information leaflet. Having read it, a written consent was signed by each participant in the presence of the researcher.

Guarantor

Jonathan O'B Hourihane

Contributorship

AG reviewed the literature. AG, LK and JO'BH conceived the study and all were involved in gaining ethical approval. AG collected the data, performed statistical analysis and wrote the first draft of the manuscript. AK also performed statistical analysis. All authors reviewed and edited the manuscript and approved the final draft.

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