The aim of this study was to analyse the influence of stump skin problems on functioning in daily life in lower limb amputees. A cross-sectional study was performed by means of a questionnaire containing 9 questions assessing functioning in daily life. Question scores were added to give a total score (range 0 (no influence) to 27 (maximum negative influence)). Two thousand and thirty-nine people were invited to participate, with 805 participants completing a questionnaire. Of these, 507 reported one or more skin problems. Skin problems had a negative influence on ability to perform household tasks, prosthesis use, social functioning, and participation in sports. The mean total score was 5.5 ± 4.1. This correlated significantly with the number of skin complaints (r = 0.483; p = 0.01). In linear regression analyses, gender (β = -0.15) and number of skin problems (β = 0.25) accounted for 23% of the total score. This study confirms the influence of skin problems on functioning in daily life. Key words: skin problems; amputation; lower limb; quality of life.

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Henk E.J. Meulenbelt, Jan H.B. Geertzen, Marcel F. Jonkman and Pieter U. Dijkstra

Departments of 1Rehabilitation Medicine, 2Dermatology and 3Oral and Maxillofacial Surgery, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands

Basic epidemiological data on skin problems of the stump in lower-limb amputees remain scarce (1). As an example, skin problems of the stump may affect functioning in daily life by reducing the length of time for which prostheses are worn. Clinicians treating a skin problem of the stump may instruct the amputee not to wear the prosthesis to support healing. However, such observations are anecdotal (2–5).

Several instruments have been developed and used in the field of dermatology to improve our understanding of the influence that skin problems may have on participation, perceived quality of life (QoL) and the results of treatment (6).

In the field of rehabilitation medicine there is increased interest in using QoL as an outcome in studies evaluating either the influence of a certain condition or the result of a rehabilitation program. However, it is still a challenge to properly measure QoL (7).

Based on this increased interest in the perceived QoL of amputees, it may be interesting to evaluate the influence of skin problems of the amputation stump on functioning in daily life.

To the best of our knowledge, no literature is available concerning the influence of skin problems on functioning in daily life in lower-limb amputees, although this question has been posed (8). The aim of this study was to analyse the influence of skin problems of the amputation stump on functioning in daily life, and to investigate if there is a relationship between the total number of stump skin problems and the use of prostheses.

MATERIALS AND METHODS

To assess the influence of skin problems on functioning in daily life, questions from the Dermatology Life Quality Index (DLQI) were used. The DLQI is a valid and reliable instrument for measuring the influence of skin problems on QoL (9).

Nine questions from the DLQI were adapted specifically for lower-limb amputees. Since we wanted to assess the influence of skin problems on the length of time for which prostheses could be worn by participants, we adapted one question concerning the influence of skin problems on the clothes someone wears by replacing the word “clothes” with “prosthesis”. The question concerning skin sensations (how “itchy, sore, painful or stinging” the skin was) was omitted as it did not assess activities. Instead, these skin sensations were added to the list of skin problems participants could choose from. Furthermore, the DLQI’s timeframe (“over the last week”) was changed to “over the last month”, since this was the timeframe of the questionnaire in which the questions were present. The scores for each question were added, giving a total score with a minimum value of zero (no influence on functioning) and a maximum of 27 (maximum negative influence on functioning). The questions and the response options are summarised in Appendix SI (available at http://www.medicaljournals.se/acta/content/?doi=10.2340/00015555-1023).

The questions were part of a questionnaire, which, in a previous study, had been used to identify skin problems and determinants of skin problems of the stump in lower-limb amputees (10). The questionnaire consists of a series of open and multiple-choice questions. It assesses the following parameters: demographics, characteristics of the amputation and prosthesis (whether the amputee had a liner, or used stump socks or other materials between the socket and his/her skin), activity level of the amputee, stump and prosthesis hygiene, and skin problems. The timeframe for reporting skin problems was the month prior to receiving...
the questionnaire. Participants who reported one or more skin problems were asked to answer the questions concerning the influence of these skin problems on functioning in daily life.

Subjects
Lower-limb amputees who were at least 18 years of age and had received their prosthesis through the OIM (Orthopedische Instrument Makerij: an orthopaedic workshop), or were member of the National Society of Amputees (LVvG: Landelijke Vereniging van Geamputeerden), were sent a letter inviting them to participate. This group of potential participants represents approximately 25% of the Dutch population of lower-limb amputees who use a prosthesis. Persons willing to participate returned a written form with their name and address. Our questionnaire was then sent to each participant to be completed and returned to us using a pre-paid envelope. If a returned questionnaire had missing data, an effort was made to retrieve them either through telephone contact or by re-sending the questionnaire with the missing answers highlighted. Non-respondents received a reminder by telephone or, if no number was available, by post.

Data entry
Answers to the questionnaire were entered into a database. All participants were able to report the year of their amputation. If the day of the month was unknown, the fifteenth of that month was entered as the date of amputation. If the month was missing, the first of July of that year was entered as the date of amputation. These assignments were made to allow assessment of the influence of time since amputation. If a participant reported more than one reason for amputation (e.g. trauma and infection or diabetes and infection), the most logical cause based on pathophysiological evidence was chosen and entered into the database. Due to similarities in their pathophysiology, peripheral arterial disease and diabetes were entered as a single reason for amputation.

For participants who had undergone a bilateral amputation (n = 30), the following procedure was followed. When both lower limbs were amputated at the same level, we determined on which side the skin problems were reported and used that side in statistical analyses (n = 6). When a participant reported similar skin problems on both residual limbs, one side was randomly chosen for analysis (n = 11). If it was not reported which stump had been affected by skin problems, the available data were checked to determine whether the participant had reported the occurrence of skin problems in the month prior to filling in the questionnaire. In such cases (n = 6), one side was randomly chosen for analysis. When the participant’s two limbs had been amputated at different levels, we verified whether the stump more affected by skin problems had been identified. If so, this side was used in the statistical analyses (n = 7). All data were checked for correct entry.

Data analysis
Data analysis was performed using SPSS 16.

Determinants were entered backwards stepwise in a linear regression analysis with the total score as the outcome. The determinants were selected, using clinical experience, based on the hypothesis that they might influence functioning in daily life (Table I). If a determinant was ordinal in the questionnaire it was dichotomised prior to analysis (rendering it either “present” or “absent”). The chosen determinants were tested for multicollinearity.

When conducting the linear regression analysis with total score as the outcome measure, the residuals were not normally distributed. Thus, one of the assumptions of linear regression was not met. As a result, we transformed the total score by taking the square root of each total score and using it as the outcome measure in the analysis. The resulting residuals followed a normal distribution. Determinants which had a statistically significant association with the total score were analysed to evaluate if the mean total score differed between the group where the determinant was present and the group where the determinant was absent. To analyse the association between number of skin problems reported and total score, a Pearson correlation coefficient was calculated. A one-way ANOVA was performed to measure the association between number of skin problems and prosthesis use.

RESULTS
A total of 2,039 persons were invited to participate. The initial number was 2,142, but we discovered that some people had received two invitations as a result of their satisfying both the OIM and LVvG inclusion criteria. Of the 1,082 respondents, 872 agreed to participate. Eight-hundred and sixteen questionnaires (40%) were eventually returned of which 805 were suitable for statistical analysis.

A total of 507 participants (63%) reported one or more skin problems in the month prior to receiving the questionnaire. Their characteristics are summarised in Table II.

Most amputations were either transtibial (49%; n = 249) or transfemoral (32%; n = 163). The most common reasons for amputation were trauma (44%; n = 225) and peripheral arterial disease/diabetes (23%; n = 117). One-hundred and seventy participants (34%) had a paid job. Sixty-one percent (n = 310) walked less than 500 m/day. Fifty percent used a liner.

The reported symptoms are listed in Table III. The most frequently reported skin problems were profuse sweating (50%; 95% CI: 46–55), redness of the skin persisting for more than one minute after doffing of the prosthesis (46%; 95% CI: 42–51), and sensitive skin (36%; 95% CI: 32–40). Of the participants who reported one or more skin problems, 25% (95% CI: 21–29) were forced to wear their prosthesis less frequently as a result of the skin problem.

Table I. Summary of the determinants analysed in the regression analysis

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Number of skin problems reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Time since last amputation (years)</td>
<td></td>
</tr>
<tr>
<td>Amputation level</td>
<td></td>
</tr>
<tr>
<td>Reason for amputation</td>
<td></td>
</tr>
<tr>
<td>Bilateral amputation</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
</tr>
<tr>
<td>Presence of co-morbidity</td>
<td></td>
</tr>
<tr>
<td>Complaint affecting the non-amputated leg</td>
<td></td>
</tr>
<tr>
<td>Use of a liner</td>
<td></td>
</tr>
<tr>
<td>Use of a walking aid</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
</tr>
<tr>
<td>Frequency of stump washing</td>
<td></td>
</tr>
<tr>
<td>Complaint of smell when doffing prosthesis</td>
<td></td>
</tr>
<tr>
<td>Previous use of a different prosthesis</td>
<td></td>
</tr>
<tr>
<td>Number of skin problems reported</td>
<td></td>
</tr>
</tbody>
</table>

As a result, we transformed the total score by taking the square root of each total score and using it as the outcome measure in the analysis. The resulting residuals followed a normal distribution. Determinants which had a statistically significant association with the total score were analysed to evaluate if the mean total score differed between the group where the determinant was present and the group where the determinant was absent. To analyse the association between number of skin problems reported and total score, a Pearson correlation coefficient was calculated. A one-way ANOVA was performed to measure the association between number of skin problems and prosthesis use.
The Pearson correlation between number of skin problems and total score was 0.48 ($p = 0.01$). The results of the linear regression analyses are summarised in Table V. Determinants with statistically significant associations with total score were gender and number of reported skin problems. Males (5.2 ± 4.0) had a significantly lower mean total score than females (6.0 ± 4.3) ($p = 0.03$; Mann-Whitney $U$ test). The interaction between these two determinants was tested, but it did not contribute significantly to the model. To

On average, 2.9 ± 1.7 skin problems per participant were reported in the month prior to receiving the questionnaire (Fig. 1).

The responses to questions concerning the influence of skin problems on functioning in daily life are summarised in Table IV. Notably, ability to perform household tasks, prosthesis use, social functioning, and participation in sport were negatively affected by the presence of skin problems.

A total of 498 participants reported that the question relating to the influence of skin problems on prosthesis use was applicable. Subdivision of these participants by their response gave the following results: “not at all” (2.2 ± 1.7 skin problems), $n = 172$; “a little” (2.9 ± 1.4 skin problems), $n = 201$; “a lot” (3.6 ± 2.0 skin problems), $n = 88$; and “very much” (4.1 ± 1.7 skin problems), $n = 37$.

One-way ANOVA revealed the existence of statistically significant inter-group differences ($F_{3,494} = 25.50; p < 0.01$). The median (IQR) total score was 5 (2 to 8). The Pearson correlation between number of skin problems and total score was 0.48 ($p = 0.01$). The results of the linear regression analyses are summarised in Table V. Determinants with statistically significant associations with total score were gender and number of reported skin problems. Males (5.2 ± 4.0) had a significantly lower mean total score than females (6.0 ± 4.3) ($p = 0.03$; Mann-Whitney $U$ test). The interaction between these two determinants was tested, but it did not contribute significantly to the model. To

Fig. 1. Frequency of reported skin problems in participants reporting at least one skin problem.
were of moderate or severe influence on a specific parameter.

Therefore be 6.4 (2.53 × 2.53), meaning that her present
score for a person with these characteristics would
obtain the total score. The estimated average total
measure, this outcome must be multiplied by itself
square root of the total score was used as the outcome

Concerning gender, the mean total score was signifi-
cantly higher in female participants than in males, sug-
gest that skin problems of the stump have a greater
fluence on functioning in daily life in the former. This
might be explained by the results of a previous study,
which assessed self-reported skin problems. In that
study, female gender was found to increase the risk of
skin problems (10). This result should be interpreted
with caution, as self-reported skin problems correlate
poorly with observed skin problems (13). Nevertheless,
an explanation for the increased risk of skin problems
may be that females tend to give more attention to
medical problems (14).

In the linear regression model, only 23% of the vari-
ance in the total score could be accounted for. This low
percentage indicates the likely existence of other deter-
minants that were not assessed in this study. Perhaps
in future studies determinants that were not assessed
in this study, e.g. characteristics of the prosthesis or
other characteristics of the activity level of the amputee,
should be assessed more specifically.

The clinical implication of the total score of the reg-
ression model has yet to be established. A previously
published guideline for the DLQI (11) may be of some
assistance in enhancing conversion of the total score to
a score that can be used in clinical practice. However,
this guideline is based on the scores of the original DLQI
from which our questionnaire was adapted. Thus, direct
comparison is not possible. Nevertheless, it provides
an indication of the impact of skin problems affecting
the amputation stump on functioning in daily life. Meas-
ing changes in total score over time may give an
indication of the success of skin treatments.

A significant relationship was found between the
umber of skin problems reported and the reported
fluence of skin problems on the use of prostheses.
The magnitude of this influence may differ between
lower-limb amputees, dependent on their need to use
of their prostheses while performing certain activities.
Research has shown that lower-limb amputees who
usually perform recreational activities using a prosth-
thesis are also able to perform these activities without
a prosthesis, but with decreased ability (15). Thus, the
fluence of skin problems on functioning in daily life
will vary depending on the activities undertaken and
the need for a prosthesis to perform those activities.
Most of the questions use a 5-point Likert scale (“very
much”/“a lot”/“a little”/“not at all”/“not relevant”),
and it is therefore possible to assess the impact of skin
problems using an ordinal scale. However, it cannot
establish whether the influence of a skin problem on a
pecific activity is primarily caused by the skin pro-
lem or the fact that the prosthesis cannot be worn. The
initial activity level of an amputee may also influence

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Table IV. Responses to questions concerning the influence of skin problems on functioning in daily life

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% (%):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household tasks (454)</td>
<td>28 (172)</td>
</tr>
<tr>
<td>Use of prosthesis (498)</td>
<td>25 (125)</td>
</tr>
<tr>
<td>Social functioning (473)</td>
<td>21 (99)</td>
</tr>
<tr>
<td>Participation in sport (230)</td>
<td>15 (35)</td>
</tr>
<tr>
<td>Labour (277)</td>
<td>9 (25)</td>
</tr>
<tr>
<td>Treatment (377)</td>
<td>9 (34)</td>
</tr>
<tr>
<td>Embarrassment (507)</td>
<td>3 (15)</td>
</tr>
<tr>
<td>Relationships (458)</td>
<td>3 (14)</td>
</tr>
<tr>
<td>Sex (375)</td>
<td>3 (11)</td>
</tr>
</tbody>
</table>

Each parameter was investigated using a 4-point scale (“none”, “light”, “moderate”, “severe”), with the additional option of reporting that it was not applicable.

Percentage and number of participants who reported that their skin problems were of moderate or severe influence on a specific parameter.

analyse possible cumulative effects of multiple skin
problems, the square of the number of skin problems
was also entered in the analysis. It did not contribute
significantly to the regression analysis. Gender and
number of reported skin problems accounted for 23%
of the variance of the total score.

On the basis of the results of the regression analyses,
the average total score can be estimated. For example,
a female reporting four skin problems has a regression
score of 2.53 (1.53 + (0 × -0.15) + (4 × 0.25)). Since the
square root of the total score was used as the outcome
measure, this outcome must be multiplied by itself
to obtain the total score. The estimated average total
score for a person with these characteristics would
therefore be 6.4 (2.53 × 2.53), meaning that her present
skin problems have a minor to moderate effect on her
functioning in daily life (11).

DISCUSSION

Number of skin problems and gender were signifi-
cantly associated with the influence of skin problems
on functioning in daily life in lower-limb amputees.
Determinants considered to be of potential influence
prior to the study (see Table I), such as level of ampu-
tation, co-morbidity and age, which have all been found
to influence the rehabilitation process (12), did not
contribute significantly to the regression equation. To
avoid obvious interactions between the model and the
total score, we did not include determinants that were
assessed by the nine questions, such as employment
status and participation in sport (see Appendix SI).

Concerning gender, the mean total score was signifi-
cantly higher in female participants than in males, sug-
gest that skin problems of the stump have a greater
fluence on functioning in daily life in the former. This
might be explained by the results of a previous study,
which assessed self-reported skin problems. In that
study, female gender was found to increase the risk of
skin problems (10). This result should be interpreted
with caution, as self-reported skin problems correlate
poorly with observed skin problems (13). Nevertheless,
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lem or the fact that the prosthesis cannot be worn. The
initial activity level of an amputee may also influence

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Table V. Linear regression model for predicting total score

<table>
<thead>
<tr>
<th>Determinant (and coding)</th>
<th>beta</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male=1, female=0)</td>
<td>-0.15</td>
<td>0.07</td>
<td>0.03</td>
</tr>
<tr>
<td>Number of skin complaints reported</td>
<td>0.25</td>
<td>0.02</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Constant</td>
<td>1.53</td>
<td>0.08</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

SE: standard error.
the extent to which his/her skin problems affect his/her functioning in daily life. Finally, the use of a total score may be inadequate to assess specific problems, only giving a general impression of the influence of skin problems of the stump on functioning in daily life. It is known that loss of mobility, problems with prostheses, and participation in social activities (which may be negatively influenced by skin problems, as reported by 25% of participants (see Table IV)) are predictors of perceived QoL (16). A qualitative study incorporating a semi-structured interview may provide further information regarding the influence of skin problems on functioning in daily life. Such a study could seek to assess the activity levels of amputees prior to the development of skin problems.

Several methodological factors may have influenced the results of this study, including several types of bias. A postal questionnaire may lead to information bias if participants do not answer the questions adequately. Selection bias may have occurred, as not all potential participants were willing to participate. As we have no descriptive data for the non-participants, we are unable to compare the characteristics of the participants and non-participants. There may be recall bias as a result of participants reporting the presence of previous skin problems. The one-month timeframe was specifically chosen to minimise this potential bias.

To the best of our knowledge there is no existing Dutch questionnaire to assess the influence of skin problems on functioning in daily life. The DLQI was chosen as it provides a valid and reliable scale for evaluating the influence of skin problems on QoL (9). We adapted certain questions to make the questionnaire more suitable for lower-limb amputees. These adaptations were made because we found no suitable questions in the literature, and because the questions in the DLQI were, in our opinion, the most suitable available. To facilitate replication in future studies, we present the questions used as an appendix (Appendix SI). As this is the first time this set of questions has been used to assess this domain, the reliability and validity cannot be established. In future studies, a question concerning the influence of skin problems on the time for which prostheses can be worn should be included to the original version of DLQI.

Lower-limb amputees were invited by letter to participate in a study concerning skin problems of the stump. The response rate for the 2,039 invitees was 40%. Although it was clearly stated that lower-limb amputees without skin problems were also welcome to participate, they were potentially less likely to respond. The design of this study, a survey based on a postal questionnaire, may have contributed to the low response rate (17).

This low response rate may mean that the results of our study do not fully reflect the true extent of the observed problems. It is not possible to verify any such deviation as no literature addressing the influence of skin problems of the stump on functioning in daily life exists. We performed an explorative study and the questions used may have omitted situations or activities that are problematic for lower-limb amputees who are unable to wear the prosthesis due to skin problems of the stump.

REFERENCES