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# VERIFICATION OF THE EFFECT OF HEALTH-COMPENSATION EXERCISE ACCORDING TO LEVITOVÁ AND HOŠKOVÁ ON FLAT-FOOTEDNESS AND CHANGES OF SPINE MOBILITY

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***Abstract***

*The aim of the paper is to evaluate the effect of compensatory exercises according to Levitová and Hošková on flatfoot and spinal mobility changes. The qualitative research in the form of case studies was focused on elderly people who, after an initial examination, practiced a daily set of exercises according to Levitová and Hošková for three months. All probands were subjected to a medical history, an entry and exit test using a visual analogue scale, a standing examination on two scales, an entry and exit examination on the Podoscope and Footdisc, a Tinetti test, a spinal mobility examination, and a quality of life questionnaire (SF-36). The initial examination showed uneven loading of the feet, flat feet in all probands and 80% of probands showed various foot deformities. However, the results showed improvement in all probands, in all examinations performed, in correlation with the visual analogue pain scale. There was significant improvement in fine foot motor skills, static stability and gait quality.*

***Keywords***

*Flat feet; spine mobility; Tinetti test, posture; senior age.*

## 1 INTRODUCTION

The feet are the weight-bearers of the whole body, without them it is impossible to move from place to place. Despite being one of the most stressed parts of the human body, they are neglected. The flat feet can greatly affect the quality of life of any person. Thorough foot hygiene, sufficient rest, appropriate footwear are unfortunately not part of the daily ritual as in the case of skin care, for example.

Nowadays, the fact of how the foot feels in footwear is often overlooked, but rather how it looks in the footwear. Lack of attention to the feet causes injuries and diseases that can manifest as various deformities, such as flat feet or hallux valgus. Many published papers deal mainly with flat feet in children or athletes, but the elderly age group is neglected.

There are many causes of flat feet. In general, loosening of the ligaments between the short foot muscles and the bones of the foot can be mentioned. Gradually, small deviations may appear, which may become fixed as the foot grows, and the end result is the formation of the basis for one of the foot defects. In adulthood, the weight is then attributed to overuse at work, maladjusted or even hard footwear and, of course, being overweight.

## 2 AIM

The aim was to map the verification of the effect of health-compensation exercises according to Levitová and Hošková on flat-footedness and change of spinal mobility in the elderly. The thesis deals with the use of exercises to strengthen or stretch the muscles of the flatfoot and thus to influence the position of the foot arch. Furthermore, it aims to investigate the impact of flat feet on spinal mobility, educating patients in proper care of the footplate and determining the status of probands according to the Tinetti test and the SF-36 quality of life questionnaire.

## 3 METHODS

Probands underwent an entrance and exit examination on the Podoscope and Footdisc, a standing examination on two scales, the Tinetti test, the SF-36 quality of life

questionnaire for the elderly, a spinal mobility examination and, last but not least, a visual analogue scale (VAS), which allowed subjects to rate their flatfoot-related health complications on a scale from 0 to 10.

**Intervention exercises according to Levitová and Hošková (2015)**

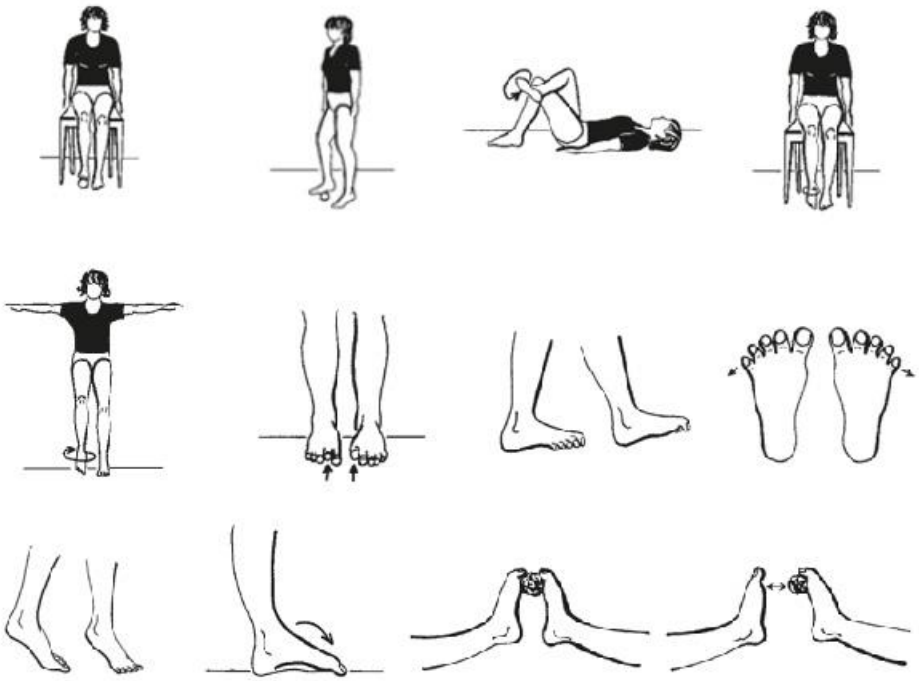

***Figure 1 - Set of exercises (Levitová, Hošková, 2015)***

Sample case report (proband 1)

**ANAMNESIS**

- Personal history - proband No. 1 *1949, female, height 172 cm, weight 75 kg
  - Varixes (since 2002)
  - Hypovitaminosis vit. D (since 2008)
  - Endometrial carcinoma (2012)
  - Arthritis of the finger joints (after chemotherapy)
  - Family history
  - Flatfoot, also had mother later in life
  - Father died at 35 of IM
- Work history
  - Retired, working in the garden
  - Previously sedentary jobs
  - In childhood was involved in athletics, nowadays long walks, cycling
- Abuses
  - Non-smoker, does not drink alcohol or coffee

**Examination on two scales**

- Right side 39 kg
- Left side 36 kg
- Difference 3 kg

***Figure 2 - Footdisc entrance examination (own source)***

**Entrance examination (Footdisc)**

- significantly reduced loading of all toes bilaterally
- bilateral reduction of the internal longitudinal arch of the foot
- greater loading of the inner edges of both feet (more left)
- assessment of the flatfoot according to Footdisc: C

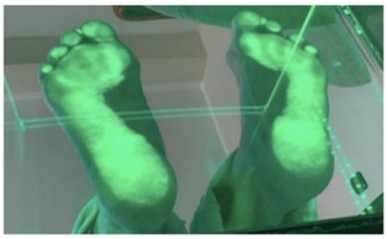

***Figure 1 - Podoscope entrance examination (own source)***

**Entrance examination (Podoscope)**

- bilateral reduction of internal longitudinal arch of the foot
- •bilateral imprint of all toes (heads of the second phalanges of both feet less load)
- •bilateral hallux valgus

***Figure 2 - Footdisc entrance examination (own source)***

**Entrance examination (Footdisc)**

- bilateral imprint of all toes
- •reduced load on the left toes
- •greater load on the inner edge of the right foot
- •assessment of the flatfoot according to Footdisc: C

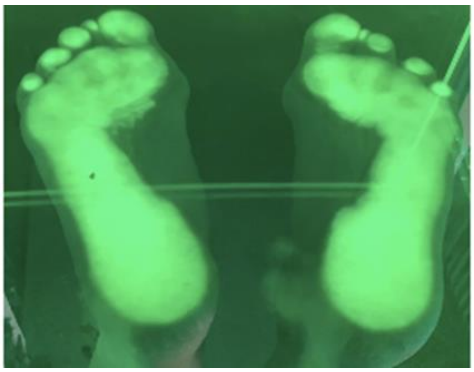

*Figure 3 - Podoscope entrance examination (own source)*

**Entrance examination (Podoscope)**

- bilateral reduction of the longitudinal internal arch of the foot
- bilateral loading of all toes (second toes of both feet less load)
- slight improvement in the degree of both bunions

*Table 1 - Spinal mobility examination (own source)*

| | | Entrance examination | Exit examination | Difference |
|---|---|---|---|---|
| **Thomayer test** | (norm 0-10 cm) | 0 cm | +4 cm | +4 cm |
| **Stibor's distance** | (norm 7-10 cm) | 7 cm | 8 cm | +1 cm |
| **Schober distance** | (norm 5 cm) | 4 cm | 5 cm | +1 cm |
| **Forestier test** | (norm 0 cm) | 1 cm | 1 cm | 0 cm |
| **Otto's distance** | (norm 3 cm) | 3 cm | 3,5 cm | +0,5 cm |
| **Cepoj test** | (norm 2,5-3 cm) | 1 cm | 2,5 cm | 1,5 cm |

*Table 2 - Tinetti test (own source)*

| Activity | Entrance examination | Exit examination | Difference |
|---|---|---|---|
| **Overall assessment of balance** | 16 | 16 | 0 |
| **Overall assessment of gait** | 10 | 11 | +1 |
| **Overall assessment of balance and gait** | 26 | 27 | +1 |

*Table 3 - SF-36 dimension (own source)*

| Dimension | Entrance examination | Exit examination | Difference |
|---|---|---|---|
| **PF** | 27 | 29 | +2 |
| **RP** | 7 | 8 | +1 |
| **BP** | 6 | 6 | 0 |
| **GH** | 17 | 21 | +4 |
| **VT** | 13 | 19 | +6 |
| **SF** | 4 | 6 | +2 |
| **RE** | 6 | 6 | 0 |
| **MH** | 18 | 22 | +4 |
| **PCS** | **57** | **64** | **+7** |
| **MCS** | **41** | **53** | **+12** |

In the case of the difference in standing on two scales there was no change. In the case of the VAS, there was a 5 point (12.5%) reduction in pain and the results clearly demonstrate the positive effect of the Levitová and Hošková exercises.

***Table 4 - Visual analogue pain scale (own source)***

| | Input data | Output data | Difference |
|---|---|---|---|
| Intensive activity | 2 | 2 | 0 |
| Interests, hobbies | 5 | 4 | -1 |
| Quiet | 6 | 5 | -1 |
| During sleep | 7 | 4 | -3 |
| **Total** | 20 | 15 | **5 point drop** |
| **Expressed as a percentage** | 50 % | 37,5 % | **12.5% decrease** |

## RESULTS

This work primarily looks at functional impairments in the plantar region of the foot and complements this with an assessment of spinal mobility, balance and gait. Table 5 shows the values of measured distances assessing spinal mobility at entry and exit examinations. The last column represents the inter-comparison for each proband and the last row shows the value of changes for each test. Cells bearing red colour illustrate deterioration in a given segment and cells coloured orange represent the fact that the proband does not fit within the values of the norm.

***Table 5 - Spinal mobility examination - input and output examination (own source)***

| | Thomayer test | Stibor's distance | Schober distance | Forestier test | Otto's distance | Cepoj test | Total |
|---|---|---|---|---|---|---|---|
| **O. C.** | +3 | +1 | +2 | 0 | +1 | +0,5 | **+7,5** |
| **B. CH.** | +4 | +2 | +1,5 | 0 | +0,5 | +0,5 | **+8,5** |
| **M. N.** | +2 | +1 | +3 | 0 | +0,5 | 0 | **+6,5** |
| **J. B.** | +4 | +1 | +1 | 0 | +0,5 | +1,5 | **+8** |
| **J. P.** | +2 | +1 | +2 | 0 | +1 | +0,5 | **+6,5** |
| **J. L.** | 0 | +2,5 | -1 | 0 | +0,5 | +1 | **+3** |
| **L. L.** | 0 | -1 | +2 | 0 | +1 | +0,5 | **+2,5** |
| **M. K.** | +2 | +0,5 | +2,5 | 0 | 0 | +1 | **+6** |
| **J. K.** | +2 | -1 | +2 | 0 | +1,5 | +1 | **+5,5** |
| **M. M.** | +5 | +2 | -1 | 0 | +1 | +0,5 | **+7,5** |
| **M. F.** | +2 | +3,5 | +1,5 | 0 | +1,5 | -1 | **+7,5** |
| **J. N.** | +6 | +1,5 | +1 | 0 | +1 | 0 | **+9,5** |
| **V. Š.** | +4 | +0,5 | +1 | 0 | +1,5 | +1 | **+8** |
| **J. Š.** | +7 | +2 | +2,5 | 0 | +1,5 | 0 | **+13** |
| **Total** | **+43** | **+16,5** | **+20** | **0** | **+13** | **+7** | **+99,5** |

Overall improvement can be observed in all probands. The most significant change occurred in the Thomayer test, which has improved overall by 43 cm in all probands.

Lumbar spine mobility primarily looks at the Schober and Stibor distances, which increased by 20 cm and 16.5 cm, respectively.

The Otto's distance is used to evaluate the thoracic spine and, according to the table, represents an improvement of 13 cm. The head and cervical spine are best represented by the Cepoj test and the Forestier fleche. While the Cepoj test shows an improvement of 7 cm, the Forestier fleche shows no change in either proband. Deterioration is seen in five probands, but only within one test. The orange fields are quite abundant in Table 5, but this is definitely not a negative finding. For most probands, these are only small deviations from the norm and can therefore be considered negligible.

***Table 6 - Tinetti test - entrance and exit examination (own source)***

| | Entrance examination Balance and gait | Exit examination Balance and gait | Difference | Assessment after exit examination |
|---|---|---|---|---|
| **O. C.** | 24 | 26 | **+2** | normal performance |
| **B. CH.** | 12 | 15 | **+3** | high risk score |
| **M. N.** | 21 | 23 | **+2** | abnormal result |
| **J. B.** | 26 | 27 | **+1** | normal performance |
| **J. P.** | 23 | 25 | **+2** | abnormal result |
| **J. L.** | 23 | 25 | **+2** | abnormal result |
| **L. L.** | 25 | 26 | **+1** | normal performance |
| **M. K.** | 24 | 26 | **+2** | normal performance |
| **J. K.** | 26 | 28 | **+2** | normal performance |
| **M. M.** | 23 | 25 | **+2** | abnormal result |
| **M. F.** | 27 | 28 | **+1** | abnormal result |
| **J. N.** | 24 | 25 | **+1** | abnormal result |
| **V. Š.** | 26 | 27 | **+1** | normal performance |
| **J. Š.** | 24 | 26 | **+2** | normal performance |

The following table describes the changes in balance and gait assessment using the Tinetti test. Again, an increase in values can be found for all probands. In general, the normal values of the Tinetti risk of fall score of 26-28 points can be considered. According to this criterion, 8 probands out of 14, which is 57%, manage normal performance after the exercise. The average Tinetti score is 26.8% in this subgroup and the average age can be quantified at 69 years. A score of less than 26 is reported by 5 probands, corresponding to 36%. The average score in this subgroup is 25% and the average age is 74 years with extremes of 80 and 60 years. A score of less than 19 points, corresponding to a critical value of a fivefold increase in the risk of fall, is achieved by 1 proband aged 79 years. The orange coloured box in Table 6 indicates a shift from one category to another, in this case a shift to the category of normal performance, i.e. the best possible outcome.

The whole examination was supplemented by the Visual Analogue Pain Scale with questions:

- How much pain do you feel during strenuous activity?
- What intensity of pain do you perceive in your interests, hobbies?
- What intensity of pain do you perceive when you are at rest?
- What intensity of pain do you perceive at night when you are awakened from sleep??

At the entrance examination, the average value was 47.5% and at the exit examination it was quantified at only 32%. Thus, there was an average pain relief of 15.5%.

*Table 7 - Quality of life questionnaire SF-36 - input and output values of two dimensions (own source)*

| Examination | Entrance PCS | Exit PCS | Difference | Entrance MCS | Exit MCS | Difference |
|---|---|---|---|---|---|---|
| O. C. | 53 | 63 | +10 | 41 | 47 | +6 |
| B. CH. | 48 | 57 | +9 | 39 | 51 | +12 |
| M. N. | 49 | 53 | +4 | 42 | 51 | +9 |
| J. B. | 57 | 64 | +7 | 41 | 53 | +12 |
| J. P. | 56 | 60 | +4 | 49 | 54 | +5 |
| J. L. | 52 | 57 | +5 | 48 | 56 | +8 |
| L. L. | 54 | 57 | +3 | 45 | 51 | +6 |
| M. K. | 53 | 62 | +9 | 41 | 50 | +9 |
| J. K. | 48 | 58 | +10 | 40 | 53 | +13 |
| M. M. | 52 | 64 | +12 | 41 | 55 | +14 |
| M. F. | 51 | 66 | +15 | 40 | 54 | +14 |
| J. N. | 56 | 68 | +12 | 48 | 61 | +13 |
| V. Š. | 49 | 63 | +14 | 51 | 66 | +15 |
| J. Š. | 55 | 70 | +15 | 44 | 62 | +18 |
| **Total** | | | **+129** | | | **+154** |

The last table compares the dimension scores for each proband. The PCS, or overall physical health, and the MCS, representing overall mental health, improved for all probands after the exit examination. In terms of PCS, there was an increase of 129 points after all probands' scores were summed together, while the MCS dimension shows an improvement of 154 points overall. If a proband shows a value below the score threshold (50 points), it is a deterioration of the individual's health status. The fields highlighted in red identify a possible deterioration in health status. In terms of physical health, only four probands show a deterioration in health, but this is only a difference of one or two points, so this value can be considered negligible. After the exit examination, all are above the cut-off point. The dimension dealing with mental health presents much worse initial results for probands. Only one proband out of fourteen is above the cut-off point of 50 points at the baseline examination, which can be considered an alarming result that can be mainly associated with isolation due to covid-19 diseases. However, a significant improvement can be observed after the exit examination for twelve probands. Only proband O.C. remains below the score threshold with a difference of three points to fifty.

## DISCUSSION

The problem of flatfoot and foot deformities is addressed within countless publications, but they are very inconsistent and the information is largely fragmented. To illustrate, Kapandji (1987) states that a large role in the decline of the foot vault is played by the muscles of this area. Another publication attaches importance to the ligamentous apparatus, which is responsible for maintaining the plantar arch, especially in standing, i.e. static, positions. If this function is reduced, the

muscles take over the function (Dylevský, Mrázková, Druga, 2000). More recent electromyographic studies, in turn, point to the fact that under normal loading the muscles are not activated at all (hitherto considered quite crucial for maintaining the arch). It is only in the case of loads that do not occur during normal walking that their contraction occurs (Dylevsky, 2003). In the elderly and senior age group, almost 75% suffer from orthopaedic foot deformities and one in thirty will undergo additional surgical assistance (Larsen, 2005).

The fragmentation of the opinions of various experts leads to the fact that the general public does not know how to face this issue and what to consider essential. The probands' problems started slowly, first manifesting as fatigue to pain in the ankle, but also in the shin and cramps in the calves with subsequent swelling. In terms of gait, which is not elastic due to flatfoot, there is often painful intervertebral joints and the spine itself as a whole. Flatfoot is combined with varicose veins of the lower limbs in almost all probands. Severe flatfoot occurred in one proband due to injury to the calcaneus. Almost all seniors have in common a previous sedentary occupation, which leads to dramatic changes not only in the foot, but also in the entire human musculoskeletal system, since a healthy foot needs movement. Another pitfall for the development of flatfoot in this population is inappropriate footwear. When taking the medical history, I also asked about the care given to the feet and the answers were almost identical, namely that they did not start to address proper footwear until late in life because of the constant pain that limited them when walking long distances. With regard to deformities in the foot area, hallux valgus was most common only in females, which was slightly alleviated in almost all probands after the exit examination.

This work also focuses on the influence of flatfoot and posture. Stabilization of body position in the vertical is a continuous dynamic process in which subcortical structures, including the cerebellum, play a role. Thus, the leg is the most distal part of the postural system that is in direct contact with the ground and is significantly involved in maintaining balance during standing and locomotion. Any pathological condition causing an increase or decrease in the curvature of the foot arch, interferes with the support of the body, whether during walking, running or maintaining upright standing (Zafiropoulos et al., 2009).

This statement has been confirmed in practice, not only in the examination of the elderly, but just by observing the performance of everyday activities. Almost all patients showed a marked valgus position of the knee joints during walking and standing, a slumped pelvis, protraction of the shoulders and, last but not least, a forward posture of the head. The use of compensatory exercise was intended to emphasize the prevention of undesirable muscular imbalances resulting from long-term repetitive poor movement stereotypes. As can be seen from the results with regard to spinal mobility testing, all seniors showed great progress after only three months of regular compensatory exercise. However, very interesting is the fact that in terms of forward head posture (Forestier's fleche) there was no improvement in any of the probands.

Furthermore, the thesis was interested in the risk of falls in the elderly, as this is one of the most common causes of deterioration of the health status of the elderly, and thus leads to subsequent complications of hospitalization, outpatient care and care in the home environment. The Czech Nurses Association reports that a senior over the age of 74 falls at least once a year (Svobodová, 2013)

In terms of static stability and quality of gait, they all show significant progress again. Most probands agreed on feeling more balanced when standing and walking. The feedback from each proband and the exit examination showed a significant effect of the compensatory exercises according to Levitová and Hošková on the flatness of the feet and mobility of the spine. The result of the therapy was most evident in the fine motor

skills of the foot. The compensatory exercises helped most of the probands to get rid of significant pain, and they were able to return to their hobbies and interests without major limitations. Some even became aware of the faulty positioning not only of the whole foot but of the body as a whole. I understand that 100% progress cannot be achieved, but just the fact that seniors continue to exercise as they have found that they feel better and some knowledge about taking care of their feet is a huge accomplishment for me.

## CONCLUSION

For objectification, the following research questions were formulated:

1. Can the use of compensatory exercise according to Levitová and Hošková influence flat feet in selected seniors?

The research question was fulfilled, with its results clearly confirming the positive effect of compensatory exercise according to Levitová and Hošková in all probands. The evaluation of the overall changes was demonstrated by the Footdisc and Podoscope examinations, which can be considered as sufficiently conclusive materials to determine the effect of compensatory exercise according to Levitová and Hošková in the group of seniors.

2. Can the examination of standing on two scales prove the effect of exercise according to Levitová and Hošková?

The research question is considered to be fulfilled, the positive effect of the Levitová and Hošková exercises has been confirmed. In all probands the physiological norm is found, i.e. the weight difference does not exceed 5 kg.

3. Can the kinesiological tests of the spine (Thomayer test, Cepoj distance, Schober distance, Stibor's distance, Otto's distance and Forestier fleche) confirm the positive effect of the exercises according to Levitová and Hošková?

The research question has been fulfilled. The numerical values clearly confirm the effect of three months of exercise according to Levitová and Hošková. Only Forestier fleche did not show any change in any of the probands after the exit examination.

4. Will the visual analogue scale pain examination confirm the effect of the Levitová and Hošková exercise on reducing foot pain?

The research question is fulfilled. The visual analogue pain scale confirmed the effect of the Levitová and Hošková compensatory exercises on flat feet by significantly reducing the number of points on the output.

5. Does the Tinetti test and the SF-36 quality of life questionnaire show a positive effect of exercise according to Levitová and Hošková in selected seniors?

The research question has been fulfilled. The positive effect of the Levitová and Hošková exercises is confirmed in all probands, both in terms of the Tinetti test, which improved static stability and balance during walking, and in terms of the SF-36 quality of life of the seniors, which is supported by the resulting numerical values.

Verification of the effect of the health-compensation exercise according to Levitová and Hošková on flat-footedness and change of spinal mobility was fulfilled. The work in all research questions clearly confirmed the positive effect of compensatory exercise in a group of probands who meet the age limit condition, namely over 65 years.

In the practical part, 14 probands (nine females and five males) were selected who come into the age category of the elderly and are afflicted by flatfoot-related pain. After undergoing an initial examination, the seniors were given a battery of exercises to practice at least once a day for three months. At the end of the three-month period, all exit examinations confirmed the positive effects of the exercises.

Plantographic examinations using Footdisc and Podoscope showed a reduction in the degree of flatfoot and various deformities in the foot area, but often revealed other postural-related abnormalities. Pain during various activities according to the VAS

decreased by an average of 15.5%. With regard to spinal mobility, which was assessed by a battery of tests, there was a conclusive improvement in a positive direction, except for Forestier fleche, which remained unchanged (see Table 5). The Tinetti test revealing the assessment of balance and gait showed data of improvement, as 57% achieved normal performance (see Table 6). The SF-36 quality of life questionnaire was designed to complement the above mentioned investigation, since the elderly group is often neglected in various studies and publications, and it is very important to pay attention to the quality of living in late life, and despite the current difficult times associated with isolation, especially in this age group, the positive effect of compensatory exercise according to Levitová and Hošková is very significant and important, which has been extensively demonstrated.

In all respects, the probands show improvement and, most importantly, they continue to exercise as they feel much better themselves. Finally, it is important to note the importance of psychosomatic influences, which are often neglected. Maintaining social contacts is important not only for this age group.

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## 7 CONTACTS

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