Leg Length Alignment Asymmetry In A Non-clinical Population And Its Correlation To A Decrease In General Health As Measured By The SF-12: A Pilot Study

Gary A. Knutson, DC†, Edward F. Owens, Jr., MS, DC††

ABSTRACT

Purpose: To determine if there is an association between a test commonly used by chiropractors as a sign of subluxation/joint dysfunction – supine leg length alignment (LLA) asymmetry - and health-related quality of life as measured by the SF-12 questionnaire, in a non-clinical population.

Design: Volunteers answered the SF-12 and background questionnaires and were then examined for supine LLA by a chiropractor blinded to their answers.

Setting: Gatherings of people in the general population.

Participants: Fifty-five unscreened volunteers.

Examiner: Chiropractor with approximately 20 years of clinical experience.

Main Outcome Measures: The association of supine LLA asymmetry with general health based on the two summary scores - physical (PCS) and mental (MCS) - of the SF-12.

Results: There were 27 volunteers with LLA asymmetry, they had a mean PCS of 49.6 and a mean MCS of 47.9. In the no-LLA asymmetry group (n=23) the mean PCS was 50.8, and mean MCS of 54.0. A multiple regression analysis found that of the variables gender, age, back pain (current/former) and LLA asymmetry, the only factor to approach significance with the SF-12 MCS/PCS was the presence of LLA asymmetry. A t-test found there was a significant difference (p=0.017) in the MCS between the supine LLA asymmetry and no-LLA asymmetry groups.

Conclusion: This pilot study suggests that in this group of volunteers (n=50) from the non-clinical general population, those who demonstrated a commonly used sign of subluxation/joint dysfunction - supine leg length alignment asymmetry - had a lower measure of general health as determined by the SF-12 survey than those volunteers without such asymmetry. Further investigation to clarify this relationship and to establish whether there is a connection between the putative entity of chiropractic subluxation and unloaded leg length alignment asymmetry is recommended.

Key Indexing Terms: Leg length inequality, Chiropractic, SF-12, quality of life

† 840 W. 17th, Suite 5, Bloomington, Indiana 47404, gaknutson@aol.com
†† Associate Professor of Research, Palmer Center for Chiropractic Research, 741 Brady Street, Davenport, IA 52803, Edward.Owens@palmer.edu

Introduction

A traditional, yet unproven, chiropractic principle is that the effects of subluxation (joint dysfunction) results in a generalized sub-optimal functioning of the body. Further, this sub-optimal functioning may be sub-clinical or asymptomatic. Given time, symptoms, including pain, are experienced. Meeker phrased this belief this way: “The basic chiropractic hypothesis would be that in a human population where health can be determined, those with a lower frequency of health would have a correspondingly higher frequency, or severity of subluxation compared to those in a higher level of health, who would have a corresponding lower level of subluxation”\(^8\).

The SF-12 is a self-administered short-form measure of general health status. The SF-12 questionnaire evaluates physical and mental health, and permits the computation of two summary scales: physical (PCS) and mental (MCS). These scales have been standardized to a mean score of 50 in the general population. The SF-12 questionnaire is recognized as being reliable\(^2\) and valid\(^2\) and has been used in a wide variety of settings\(^3,4\) including studies of orthopedic problems\(^5\).

One of the most commonly used tests or signs of subluxation (joint dysfunction) utilized by chiropractors is the leg check or alignment test\(^6,7\). Leg check tests examine subjects for the so-called short leg (LLI), which is more aptly described as leg-length alignment (LLA) asymmetry in an unloaded posture. Supine physiologic or functional LLA asymmetry does not appear to be anatomic in origin\(^8\), and is suspected of being caused by hypertonicity in supra-pelvic and pelvic muscles, which results in pelvic torsion in an unloaded state\(^8,11\). While evidence points to intra- and inter-examiner reliability of leg checks\(^12,13\),
and for the supine test, validity relative to recurrent back pain\textsuperscript{14}, there is no consensus opinion as to the value of leg checks as a clinical test.

If LLA asymmetry - as a sign/test for subluxation/joint dysfunction - is a functional disturbance, it may be expected to be associated with an alteration in the rating of general health. This possibility gives rise to a null hypothesis; that there is no relationship between health-related quality of life as rated by the SF-12 and the finding of a supine LLA asymmetry on volunteer subjects in the general population.

Materials and Methods

The population and methods of data collection have been described in detail previously\textsuperscript{14}. This study involved subjects in the general (non-clinical) population. Some of the places volunteers were solicited included meetings, parties, a reunion and a class. Typically, an announcement would be made at the beginning of a gathering explaining that the examiner was present for the purposes of a research project. The attendees were informed that participation in the study was on a purely voluntary basis and was totally anonymous (no record of name, address or phone number), and were asked to read and sign an informed consent form. Volunteers, aged 20 and older, were instructed to fill out the SF-12 health survey and attached questionnaire to the best of their ability and without asking the examiner any questions. Once completed, the paperwork and subject were assigned a number.

Numbered volunteers were then examined for postural distortions, including standing pelvic unleveling, foot rotations and LLA asymmetry while supine. For the foot rotation and supine leg check, a standard (not portable) table was used. This table is trapezoidal, wider at the foot (18 in.) tapering to 8 in. at the headpiece, standing 18 in. off the floor and is covered with slick naugahyde. The examiner demonstrated to the volunteer the proper method of lying down supine on the examination table. The volunteer stood at the end of the table, sat down, then using their arms pulled themselves evenly towards the head of the table until their just the ankles and feet extended off the table. The subject was then instructed to lie back so that their head rested on the headpiece. The volunteer was told to take a breath, relax and relax.

To perform the supine leg check, the examiner squats at the foot of the table, then lightly grasps and cups the heels of the subjects’ shoes. The feet are then de-rotated and squared to remove any foot rotation asymmetry. The examiner compares the positioning of the subject’s heel/sole interface from side to side\textsuperscript{15}. LLA asymmetry was then estimated, with 1/8” or less considered to be “even” as was the protocol in the Hinson and Brown reliability test\textsuperscript{13}.

Results

Data on supine LLA and SF-12 scores were collected in this way on 55 volunteers. Five subjects were eliminated, 3 with no LLA asymmetry, and 2 with LLA asymmetry, because they were being treated (M.D., D.O., D.C., P.T., massage therapist) for back pain. In the remaining population, the average age was 40.3 (SD 10.9), range 20-65, and consisted of 35 females and 15 males.

SF-12 scores were calculated by entering the responses to the twelve questions into a specially designed spreadsheet. The spreadsheet was tested for accuracy in advance by comparing results on a test data set provided by the developers of the questionnaire.

A multiple regression model was employed to explore the relationship between the SF-12 scales of PCS and MCS and the data collected on the variables of gender, age, back pain (current/previous), and LLA. The data was processed using SPSS software [SPSS for Windows, SPSS, Inc.]. The details of that model are shown in table 1. PCS and MCS are considered dependent variables and the extent to which the other variables influence them independently was evaluated with the multiple regression method. None of the factors (age, the presence of back pain, gender, or the presence of leg length asymmetry) were related to the PCS factor. On the other hand, the analysis showed that MCS was linearly related to LLA (p=0.053) and the relationship was in a negative sense, i.e. the presence of LLA tended to produce a decrease in MCS. To further explore the effects of LLA on MCS, the subjects were subdivided into two groups, those with and those without LLA. The average SF-12 scores for the no-LLA asymmetry group were 50.8 for the PCS and 54.0 for the MCS. In the LLA asymmetry group the average scores were 49.6 for the PCS, and 47.9 for the MCS (table 2). A chart of the MCS scores of each patient shows that the subjects with balanced LLA had consistently higher scores (fig 1). Only 4 of the 23 subjects (17.3%) with no LLA asymmetry had scores below the norm value of 50, with 1 subject scoring below 40. On the other hand, 11 of 27 subjects (40.7%) exhibiting LLA asymmetry had scores below 50 and 7 of those were below 40.

A one-tailed homoscedastic t-test (Excel, Microsoft Office for Windows 95) comparing the MCS of those with LLA asymmetry to those without was performed. These results gave a finding of p=0.017, and with an alpha level of 0.05, the SF-12 MCS between the two groups (LLA asymmetry and no-LLA asymmetry) was significantly different (table 2). The rationale

### Table 1. Details of the Multiple Regression Model

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>PCS-12</td>
<td>Constant + a<em>AGE + b</em> B_PAIN + c* GENDER + d* LLA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficients</td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>(Constant)</td>
<td>70.610</td>
<td>4.681</td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>-.497</td>
<td>.113</td>
<td>-.562</td>
</tr>
<tr>
<td>B_PAIN</td>
<td>-.834</td>
<td>2.821</td>
<td>-.039</td>
</tr>
<tr>
<td>GENDER</td>
<td>.607</td>
<td>2.858</td>
<td>.029</td>
</tr>
<tr>
<td>LLA</td>
<td>-.106</td>
<td>2.684</td>
<td>-.006</td>
</tr>
</tbody>
</table>

| MCS-12       | Constant + a*AGE + b* B_PAIN + c* GENDER + d* LLA |
| Coefficients | B                             | Std. Error                | Beta | Sig.      |
| (Constant)   | 54.492                        | 6.947                     |      | .000      |
| AGE          | .01000                        | .138                      | .011 | .943      |
| B_PAIN       | .06455                        | 3.452                     | .003 | .985      |
| GENDER       | -1.007                        | 3.497                     | -.046| .775      |
| LLA          | -6.514                        | 3.285                     | -.323| .053      |
Table 2. Breakdown of subjects by whether LLA was present or not.

<table>
<thead>
<tr>
<th>SF-12</th>
<th>No LLA asymmetry (n=23)</th>
<th>LLA asymmetry (n=27)</th>
<th>t-test</th>
<th>Physical Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PCS (norm 50)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>49.6</td>
</tr>
<tr>
<td>Mental Summary</td>
<td></td>
<td></td>
<td></td>
<td>MCS (norm 50)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47.9</td>
</tr>
</tbody>
</table>

for the use of a one-tailed t-test and the setting of the alpha level are discussed below.

Discussion

This pilot study showed that in a group of volunteers from the non-clinical general population, those who demonstrated supine leg length alignment asymmetry had a lower measure of general health as determined by the SF-12 survey than those volunteers without LLA asymmetry, particularly in the mental health index. The results of this pilot study should be viewed as interesting, but preliminary, needing further verification.

While the subjects examined were from the non-clinical population, this was not a statistically defined cross-section of the general population. This potentially skewed sample leads to some problems. There were far more women volunteers (70%) than men (30%), yet a higher percentage of men (87%) than women (40%) had supine LLA asymmetry. It was previously demonstrated that those with LLA asymmetry had significantly more intense pain and were more likely to have recurrent pain, so it is entirely possible that men may have been more likely to volunteer for the study only if they had back pain. However, the multiple regression analysis found no relationship between gender and SF-12 scores. Further exploration into how the subjects in this study compare to a statistically defined population have been described in detail previously.

Another possible confounding factor is that a large percentage (74%) of the volunteers were experiencing, or had experienced, back pain. Prior back pain is considered to be a risk factor - a cause of or caused by - psychological “distress”. Again, the multiple regression analysis found no relationship between current/former back pain and the SF-12 MCS, indicating that any psychological distress possibly due to back pain did not have a significant effect on the MCS.

Some discussion regarding the use of the one-tailed t-test is necessary. The multiple regression model demonstrated a negative linear relationship between LLA and MCS that almost reached statistical significance (p=0.053, table 1). Also, past studies have shown that LLA asymmetry is associated with increased levels of pain intensity, recurrent back pain and significantly decreased SF-36 scores. Hence, the hypothesis under investigation was whether LLA asymmetry is associated with lower MCS scores. In this case, the one-tailed t-test is appropriate.

Comparing the LLA asymmetry and no LLA asymmetry groups against the SF-12 scores involved two t-tests, one for the MCS and one for the PCS. When more than one statistical test is applied to a set of data, some call for the application of what is called the Bonferroni correction. If enough statistical tests (set at a standard level of significance of 0.05) are applied to a set of data, the odds that a test will meet the required level of significance by chance increases. In ten tests this chance increases to 0.40, which is about one in two. To prevent accepting a result as being a significant difference when it is not (Type 1 error), the Bonferroni correction is applied. Essentially, the level of significance is divided by the number of tests done on the data. The Bonferroni correction, however, increases the chance of not accepting a significant finding when in fact there was effect (Type 2 error). As such, the application of a Bonferroni correction is an issue about which there is much ongoing discussion.

In this study two t-tests were used, one each for the PCS and MCS. Applying the Bonferroni correction on this set of data – MCS for LLA asymmetry vs. no LLA asymmetry - would lower the significance level (alpha) to 0.05/2 or 0.025. However, it is arguable whether the Bonferroni correction should be used when only two t-tests are applied to a set of data. Regardless, the results for the MCS values of LLA asymmetry vs. no LLA asymmetry calculated to p=0.017, which is less than what is necessary with a strict application of the Bonferroni correction.

A compromise in cases of questionable use of the Bonferroni correction is to set the significance level at the standard 0.05 level for each test. If a relationship is found, it should be confirmed in a separate study. This is the position we take regarding the data and the Bonferroni correction in this study.

Consideration of the LLA asymmetry and no LLA asymmetry group MCS tells us there is a statistically significant difference between the two groups in the area of general mental health, but does this 6-point difference mean anything clinically? Ware and his associates, the developers of the SF-12, have used the measure in dozens of studies in clinical populations as well as the general population. In cross-sectional studies of the general population, the presence of such conditions as vision impairment and chronic lung disease is associated with a 3-point difference in MCS scores. The presence of depression is associated with a 9.3-point difference in MCS. In a cross-sectional study of patients seeking care, the presence of asthma was associated with a 6-point depression in the MCS score. In a 1-

![Image](https://example.com/image.png)

Figure 1. The values of SF-12 Mental Component Score for subjects with balanced LLA and LLA asymmetry.
year longitudinal study, the average change in MCS score for patients who reported that they were “a lot more limited” was 6.6. If they said they were “somewhat more limited” their MCS score dropped by 3.9 on the average.

In another series of studies, the MCS was correlated to mental health by comparing scores to a set of instruments designed to assess depression, stress and life satisfaction. A 5-point decrease in MCS, from the 50-54 range to the 45-49 range, was associated with a 55% increase in the likelihood of depression, a 67% increase in the likelihood of stress, and a 47% decrease in the perceived level of life satisfaction. These studies suggest that changes on the order seen in this study - 6-points - are clinically as well as statistically significant.

MCS stands for mental component score of the SF-12, and it was surprising that this aspect of general health - ostensibly the mental component - is what was found to be significantly different between the LLA asymmetry and no-LLA asymmetry groups. One might expect the postural distortion - theoretically muscular hypertonicity causing pelvic torsion - to affect the physical aspects of health (PCS), not the mental. In an attempt to understand this finding, each MCS question on the SF-12 survey was examined for its difference between the two groups. One question, “During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)”, which has 5 possible answers, was found (t-test) to have significantly (P<0.002) different results between the LLA asymmetry and no-LLA asymmetry groups. The question, even though placed in the category of MCS, does ask for rating both mental and physical health problems as they relate to social activities.

The SF-12 is a shorter version of the longer general health survey, the SF-36; however, the questions used on the SF-12 survey are the same. In the SF-36, the above question regarding social activities comes under the heading of “social functioning” (SF). A practice-based study that encompassed data from specific upper cervical chiropractic practices - a study of clinical patients - using the SF-36 as the measure of general health, has been reported in the literature. This particular chiropractic technique procedure uses the same supine LLA asymmetry check to determine the presence of subluxation/joint dysfunction and the necessity of x-ray and adjusting. In the Hoiriis et al. study, the initial physical functioning scores were much lower than population norms, as might be expected in a clinical situation. In addition, the initial score of “social functioning” (which is based on two questions, one of which is the same as noted above in the SF-12 survey) of the incoming patients was found to be significantly lower (P<0.01) than population norm (64 vs. 83.3). That SF value rose to a value of 86 - higher than the population norm - at maximal improvement after a course of chiropractic care. [Note that the while the SF-12 scores are normed so that a score of 50 equals the general population norm, the SF-36 subscale scores are not normed. The SF-36 scores range from 0 to 100 and the general population norm for the Social Functioning subscale is 83.] The practice-based study had no control group, hence changes in the SF-36 could have been due to the natural course of the conditions. However, there was also a significant change (p<0.05) in the SF score pre-post care in chronic cases (symptoms longer than 8 weeks duration), which are less likely to spontaneously resolve over time.

In the study described in this paper, subjects were recruited from the general, non-clinical population. In this population, the subjects demonstrating supine LLA asymmetry had significantly decreased MCS over their no-LLA asymmetry counterparts. While it is premature to call this decrease in general health associated with a sign of subluxation/joint dysfunction as proof of “the basic chiropractic hypothesis” as termed by Meeker, the evidence does seem to point this way. The major problem is that LLA asymmetry, while often used as a sign of subluxation/joint dysfunction, has not been adequately demonstrated to be directly related to such an, as yet, putative physiological entity. However, some blinded case studies do make the connection between suspected dysfunction in the upper cervical spine, treatment and LLA asymmetry changes.

Further, the decrease in the general health of the LLA asymmetry group was not enough to cause those subjects to seek care. It could be argued that this group was asymptomatic relatively to a clinical encounter. Again, while it is premature to call this contextual asymptomatic state associated with a sign of subluxation as proof of the hypothesis of the “asymptomatic” or “silent” subluxation, this evidence does point in that direction.

Finally, the SF-36 rated decrease in social functioning of the symptomatic expressive new clinical patients in the Hoiriis et al. study adds continuity to the SF-12 rated decreased social functioning in the asymptomatic (not seeking treatment) general population LLA asymmetry group in this study. It is possible to formulate a hypothetical relationship between LLA asymmetry and decreased general health (social functioning) that is consistent with the results presented here and those published previously. The sequence of events appears to proceed like this: subluxation/joint dysfunction leads to LLA asymmetry; LLA asymmetry is associated with a relative decrease in general health (the SF-12 MCS) in this population, but is asymptomatic to the extent that no outside treatment (clinical encounter) is pursued; given time, physical symptoms are severe enough to prompt the subject to seek treatment, in presenting clinically for treatment, the SF-36 survey shows significant physical impairment and continuing social functioning impairment; treatment alleviates the LLA asymmetry, and the physical and social impairments as measured by the SF-36.

In order to confirm the relationship of LLA asymmetry to a decrease in the SF-12 measured MCS, a study directed solely towards that question, using a larger “n” than in this pilot study, is needed. A power analysis using the variances demonstrated in this subject pool suggest that for the effect size seen (0.64), 48 subjects per group would achieve a 90% power. It would also be good to ensure that the next population has a more balanced ratio of genders.

While none of the other variables (age, gender, and the presence of low back pain) accounted for the significant difference in the MCS of the LLA asymmetry vs. no LLA asymmetry groups, it is possible that some other, undetected condition might have contributed. Ware et al have published the effects of a variety of acute and chronic conditions on the general health summary scores. A future study should survey subjects for the
presence of conditions for which there is a known effect on the SF-12, such as asthma, heart disease, chronic depression and back pain.

A longitudinal study of changes in health status of a group in the general population with LLA asymmetry, yet asymptomatic regarding care, would be ideal. A key question is whether the presence of LLA asymmetry predicts the eventual need for care. Additionally, research into the relationship of LLA asymmetry to subluxation/joint dysfunction is necessary.

Conclusion

This pilot study suggests that in this group of volunteers (n=50) from the non-clinical general population, those who demonstrated a commonly used sign of subluxation/joint dysfunction - supine leg length alignment asymmetry - had a lower measure of general health as determined by the SF-12 survey than those without such asymmetry. The mental component scale of the SF-12 in particular was most affected and the average change was both statistically and clinically significant. Further investigation using a larger “n” to verify this relationship and to establish whether there is a connection between the putative entity of chiropractic subluxation and supine leg length alignment asymmetry is recommended.

Acknowledgements

We would like to acknowledge Dr. Susan Brown, Dr. Kathryn Hoiriis and Dr. Brian McAulay for their assistance with statistical analysis and interpretation.

References