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BSc (Hons) Podiatry
University of Wales
Final Year Project.

“The effects of cigarette smoking on lower limb circulation in young adults:
A comparison between smokers and non-smokers aged 18-35”.

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University of Wales for the degree of Bachelor of Science.

In submitting this report, I confirm that this is my own work and has not
been submitted for any other degree or for publication.
Acknowledgements

Firstly I would like to thank my family for their constant support and encouragement throughout the three chaotic years on this course. I can now hopefully join the rest of them in working for the NHS.

Also I would like to thank my fellow course colleges and friends, we have become a close year and work well as a team. I hope we all stay in contact with each other after graduating.

Thanks to my very nice neighbour and friend Peter Strickland for helping me with my computer troubles.

And finally I would like to thank Jeff Evans and Ian Mathieson for their help and guidance during my project and all the academic staff for their support throughout the course.
Abstract.

This research project was conducted to investigate the effects of cigarette smoking on the peripheral vascular status of the younger individual, aged 18-35. Vascular status was determined by the ankle brachial pressure index (ABPI); a validated and non-invasive diagnostic tool.

Twenty participants were selected from students enrolled on the university’s Podiatry programme, ten current cigarette smokers and ten non-smokers. Smoking participants were eligible on the criterion of having smoked a minimum of 5 cigarettes for a minimum duration of one year. All participants qualified for “good health”, by satisfying criteria established by a medical screening questionnaire.

Each participant’s leg was randomly selected to obtain one ABPI reading. ABPI was calculated by obtaining average systolic pressure of dorsalis pedis and posterior tibial from the randomly selected leg and dividing this by the average of the left and right systolic pressures in brachial arteries. Abnormal ABPI was considered as less than 1.0.

Data was collected and analysed using tables, graphs and the un-paired t-test. The statistical test failed to show any significant difference between smoking and non-smoking groups regarding ABPI levels. Discrepancies were noted and suggestions for further researched were considered.
1. Introduction.

On April 2\textsuperscript{nd} 2007 smoking ban legislation was introduced to Wales. This new law made it illegal to smoke in enclosed public places, with the intention of protecting workers and the general public from the inhalation of harmful and toxic second-hand smoke (Smoking Ban Wales 2008).

The effects of cigarette smoking are well researched and documented with many studies highlighting the health risks and impacts caused by smoking (Bergstrom 2000; Fielding & Phenow 1988). The government has funded an anti-smoking advertisement campaign aimed at reminding the general public of the possible harmful consequences of smoking, often using controversial “shock tactics” which have caused much debate (Dolman et al 2007). On October first 2007 new Welsh legislation increased the legal age of selling tobacco related products from 16 to 18 as part of the British government’s initiative to deter young smokers (Dolman et al 2007).

Evidence of the negative effects of smoking has existed for the past 200 years, this evidence however was largely ignored until the 1950s when research conclusively linked the effects of smoking to lung cancer. Smoking levels have decreased substantially over the last 60 years from an era when 40\% of women and 80\% of men smoked (Peto 2000).

The average Welsh citizen is relatively well informed of the adverse health impacts caused by tobacco smoking (Ash Wales 2008), yet despite this 2005/06 figures from NHS Wales estimate that 25\% of the current population regularly smoke. The Welsh Assembly Government compiled a report in 2007 and found that Welsh smoking levels exceed the British average and
an estimated 6,000 people in Wales die as a result of smoking related illnesses each year (Dolman et al 2007).

Howard et al (1998) recognise that smoking is widely accepted as a major risk factor for the development of clinical cardiovascular disease. Medical research has indicated that chronic smoking can lead to various health problems, particularly those affecting the cardiovascular and respiratory systems (Peto 2000).

The estimated economic expenditure of treating smoking related illnesses and diseases costs the NHS £1.7 billion annually, as shown by increased numbers in GP visits, prescriptions, medical treatments and surgical interventions amongst smokers (Dolman et al 2007).

However, a counter argument exists suggesting that smokers may not cost society as much because they do not live so long, and the taxation paid for smoking more than covers the costs spent by the NHS. The tax revenue generated from selling tobacco and its products make the British government an estimated £7 billion annually (Dolman et al 2007).

In 2008 89% of the cost of a packet of cigarettes goes to the treasury. This taxation rate is justified by the Department of Health's opinion that it will encourage less people to smoke and prompt more smokers to give up (Department of Health 1998).

Whatever the viewpoint it is evident that smoking places a huge burden on the NHS, and smoking cessation is a very important preventative health measure that should always be addressed with the aim of continually making the public aware of the negative health impacts caused by smoking.

“Quitting smoking is associated with a substantial reduction in risk of all-cause mortality among patients” (Critchley & Capwell: 86).
The role of the health professional in understanding and reinforcing healthful behaviours to their patients cannot be underestimated and forms a very important basis in preventative health care. This includes discouraging patients from smoking, regardless of their sex, medical history, age and vascular status.

The negative effects of smoking have been well documented concerning its influence on the respiratory system, endocrine system, immune system and cardiovascular system (Barendregt et al (1997) cited in Greiss & Bhargava 2006). The cardiovascular impairments of the lower limb peripheries caused by smoking will be the most noticeable to the podiatrist. Smoking is considered to be a very influential factor in predisposing an individual to peripheral vascular disease (Frick & Seals 1994).

This study aims to identify whether there is peripheral vascular impairment in the young smoker compared to the young non-smoker. The harmful effects of long term smoking are well documented, extensive research is considerably lacking however, for the effects of smoking on the peripheral vascular supply of the younger person (Kessler 1995). This study aims to identify whether smoking is in fact already causing harm to younger individuals as characterised by lower limb vascular impairment amongst this age group. Although it is unlikely that short term smoking will cause a significant reduction in ABPI (Czernin 1995), a small reduction may suggest that the short term effects of smoking are already taking their toll on lower limb vascular health.
2. Review of Literature

2.1 Smoking and Health

Overwhelming and unprecedented evidence from dozens of authorities and research studies over the past 150 years have conclusively proven that smoking causes damage to every organ present in the human body to some detectable degree (Edwards 2004; Perkins 1992; Peto et al 2000).

“Tobacco use is the single most important preventable health risk in the developed world, and an important cause of premature death worldwide” (Fragerstorm 2002:1).

The primary diseases caused by smoking include cancers, diseases affecting the respiratory system and cardiovascular diseases. In addition, the secondary adverse effects of smoking are well documented during pregnancy and strong evidence links smoking with increasing the severity and impairing the prognosis of a multitude of pre-existing diseases & illnesses (Hays et al 1998).

2.2 Smoking and Peripheral Vascular disease

A detailed examination of the leg and foot can reveal the state of peripheral circulation and can provide the Podiatrist with valuable information. Both physical symptoms and diagnostic tools are used in the diagnosis of peripheral vascular disease (Bonham 2003). Skin temperature, pulse prominence, skin condition and blood flow are clinical features that are most commonly investigated when considering vascular function (Jelinek & Austin 2006).
McNamara & FitzGerald (2001) identify that research into the effects of smoking on the cardiovascular system is limited and given a low priority compared to the effects of smoking on the respiratory system in relation to the development of lung cancer.

Research by Peckene & Miller (1997) however highlight the primary cause of death as a consequence of smoking are those which affect the cardiovascular system. From a podiatric perspective cardiovascular impairments would present in the form of peripheral arterial insufficiency and in the worse case peripheral arterial disease (PAD).

Multiple aetiologies for the progression of peripheral artery disease exist, with smoking being documented as a highly significant risk factor (Anderson et al 1991 cited in Peckene & Miller 1997).

Long term smoking is an important risk factor for the development of peripheral vascular disease, and its consequences are characterised by a marked reduction in ABPI (McNamara & FitzGerald 2001). Cole et al (1993) document a strong association between smoking and peripheral arterial disease in their study with 76% of their participants having developed PAD as a direct result of smoking after having outlined all other possible causes. This strong correlation however is contested by Fowkes et al’s (1995) large cross-sectional study that measured the correlation between the involvement of PAD in people that have smoked consistently and those that never smoked. The study revealed that smoking did not equate to a distinctive risk factor in the development of PAD. Fowkes et al (1995) concluded that an elevated body mass index, high cholesterol, hypertension and age individually had more influence on the contractibility and progression of PAD. Despite different quantified finding amongst research studies it is accepted that there is a strong association between smoking and
the development of PAD, specifically in the older person that has smoked over a prolonged period.

Attitudes towards the ill effects of smoking are usually associated with the assumption that only high exposure levels to smoking will reveal negative health symptoms.

"Epidemiological findings [however] indicate that even passive exposure to cigarette smoke may exert detrimental effects on vascular homoeostasis" (Raupach et al 2006:386).

2.3 Age and the effects of cigarette smoking

Multiple studies link the effects of chronic smoking and PAD. Hirsch et al (2001) explain how the hardening of the arteries is a slow process that occurs over a number of years. Few studies have examined the short term effects of smoking on the peripheral arterial supply of younger people (Robbins 2000).

Short term effects of smoking on arterial wall stiffness however are documented and Kool et al (1993) analysed the properties of the arterial wall in short and long term smokers. The study revealed that smoking only one cigarette caused temporary small increases in the stiffness of the arterial wall. Arterial wall stiffness decreases the volume of blood flow through the arterial system in the lower extremities thus increasing the likelihood of peripheral vascular disease (Suzuki et al 2001).

This study will aim to measure the impact of smoking on the peripheral vascular status of the younger person from 18 to 35 years old.
2.4 ABPI as a measurement tool

“The ankle-brachial [Pressure] index is perceived as the recognized standard to establish arterial disease as it provides a simple, convenient, and non-invasive measure of the lower extremity vascular function”

(Jelinek & Austin: 153).

The ankle brachial pressure index provides numerical data for the clinician to investigate the extent of blood flow through the arterial system to the ankles. The index is calculated by measuring the maximum ankle systolic pressure and dividing this figure by the brachial systolic pressure in the arm (Wild et al 2006).

*Calculation of ankle brachial pressure index:*

\[
\text{Ankle Systolic Pressure} \div \text{Brachial Systolic Pressure}
\]

Research has suggested that the procedure gives a good indication of cardiovascular events, and is the most often used indicative tool in the diagnosis of peripheral vascular disease (Ray et al 2005). The principle behind the ABPI is to ascertain whether there is a difference in the arm blood pressure when compared to the ankle. A lower pressure at the ankle would indicate arterial insufficiency. The degree of reduction in blood pressure indicates the level of severity in arterial functioning (Al-Khaffaf & Dorgan 2005) and variation regarding “normal” ABPI values is evident amongst different authors (Appendix 1).

Several studies have shown the reliability and accuracy of the ABPI in measuring vascular disease. A study by Augustine et al (2000) demonstrated how easily and quickly physiotherapy
students were able to perform the procedure with one hours training. With 78% of them maintaining the same readings. A systematic review conducted in 2005 by Anand & Doobay found that the ABPI has a high specificity in determining the vascular outcomes of a patient, concluding that this tool has an imperative role during the vascular assessment. There are however numerous studies that have questioned the validity and reliability of measuring the ABPI. Ray et al (2005) investigated the accuracy of use amongst junior doctors and discovered that over 30% of the measurements taken on the same patient by different doctors had a wide range of readings. Indicating that nearly one third of the results obtained were incorrect. Despite the contrasting findings presented in the literature, the use of the ABPI appears to be a validated clinical test used by many health professionals, providing it is used accurately and appropriately.

2.5 Summary

The literature has demonstrated that cigarette smoking is an important factor in the development of peripheral vascular disease. There is limited research however into the effects of smoking on the peripheral vascular circulation of the younger smoking person. The ABPI is a validated tool that can accurately measure an impaired level of peripheral lower limb circulation. This measurement tool will be used to determine whether the younger smoker has already developed a detectable degree of lower limb arterial insufficiency.

2.6 Hypothesis

Younger smokers will have a greater incidence of arterial insufficiency when compared to non-smokers, characterized by a lower reading on the ABPI.
2.7 Null Hypothesis

There will be no difference in arterial supply to the lower limb of younger smokers and non-smokers.

The data for this study was obtained by an opportunistic sample selected from the available students on UWIC’s Podiatry programme. There are various sampling methods available to the researcher, some methods having greater validity than others. An opportunistic sampling method is considered less valid than a random sampling method (Armitage et al 2001). For the purpose of this study however an opportunistic sample was deemed more practical and more suitable in selecting the specific participant type required.

An information sheet was made available detailing the purpose of the study (Appendix 2) and appropriate approval was sought from the “School of Health and Social Sciences Ethics Panel” (Appendix 3). Prior to approval an application to the committee highlighted the non-invasive and well tolerated technique that would be undertaken during the study (Augustine 2000). The ethics panel granted permission on the basis of being informed of any alterations regarding participant involvement in the study.

3.1 Design

The study was conducted in the form of a clinical trial with screening questions to determine the participant’s suitability for the study (Appendix 4).

3.2 Sample

The sample population consisted of podiatry students studying at UWIC’s Podiatric Centre. 20 students volunteered to participate, 10 current active cigarette smokers and 10 non-smokers.
A stringent inclusion and exclusion criteria was utilised and incorporated into the “medical screening questionnaire” to assess whether participants were suitable for the study. The criteria ensured all participants were aged between 18-35, with a good standard of general health and suffered from no conditions that could influence arterial blood pressure. In selecting the smoking group, participants must have smoked a daily minimum of 5 cigarettes for a minimum duration of one year.

Research indicates that the sex of an individual is not a physiological influencing factor regarding arterial functioning and the progression of arterial disease. Therefore it was not necessary to have an equal number of males and females participating in the study (Jousilahti et al 1999).

3.3 Apparatus / materials

Standard sphygmomanometer calibrated in millimetres of mercury (mmHg)

Large adult pneumatic cuff, with 31-40 cm range

Standard adult pneumatic cuff, with 23-33 cm range

Hand help Doppler (Huntleigh multidopplex II) fitted with 8MegaHertz (MHz) probe.

Aquasonic coupling gel and clock timer

Medical screening questionnaire (Appendix 4)

Participant information sheet (Appendix 2)

Participant consent form (Appendix 5)
3.4 Pilot study

A pilot study was conducted on 3 non-smoking participants. The study highlighted the need for a second larger cuff due to the varying limb girths of the participants, this allowed for a 2nd larger cuff to be obtained in time for the main experiment. Conducting this pilot study allowed the experimenter to become familiar with the equipment and ABPI procedure, providing essential preparation for the main study (Polit & Beck 2004).

3.5 Procedure

The measurements were taken in the “gait lab” in Wales’s centre for podiatric studies. Before being measured the participants were given the “participant information sheet” and were given a verbal explanation regarding their involvement in the study.

Smoking participants must not have smoked for a minimum of 30 minutes before taking measurements. Once satisfied participants were required to read and sign the “consent form”. The “medical screening questionnaire” was then completed and confirmed their suitability for the study.

There is variation in the methods used to calculate the ABPI (Fisher et al 1996). Due to time restraints the ABPI of each leg was not measured. To obtain one reading a randomly selected leg was used to determine the ABPI, by flipping a 2 pence coin (heads = left leg & tails = right leg). Once the leg was selected both dorsalis pedis and posterior tibial arteries were measured individually and the mean average systolic pressure was calculated. The average systolic reading from both left and right brachial arm arteries were calculated unless pressure readings between left and right arms differed by 10mmHg then the higher brachial readings were used.
This method of measurement is advocated by Futterman (2002) were he investigated underlying pathologies leading to PAD.

Once ready each participant was required rest in a supine position for 10 minutes before measurement taking. The experimenter ensured the participants were comfortable and relaxed.

The appropriately sized cuff was secured around the right arm above the site where the brachial pulse is palpable. The ultrasound gel was then applied over the brachial pulse. The palpation of the pulse was sought using the Doppler probe, by placing the probe over the brachial pulse at an angle of 45-50 degrees, until a pulse is sounded. The cuff was inflated until the pulse could no longer be heard, then slowly deflated until the signal returned. The figure at which the pulse returned was recorded as the brachial systolic pressure reading. Procedure was repeated for the left arm. Both systolic brachial readings were obtained and average reading was calculated.

The appropriately sized cuff was secured around randomly selected ankle. Ultrasound gel was applied over the pulse of the artery being measured, either the dorsalis pedis or posterior tibial pulse. The systolic pressure readings were obtained in the same method described for the brachial pulses. Both dorsalis pedis and posterior tibial systolic pressures were taken and average ankle systolic pressure calculated. All data was written on “ABPI calculation sheet”, average ABPI of each participant was established (Appendix 6).

3.6 Methods of analysis

All the data was collected and transferred into two separate tables. Table 1 for the non-smoking group and table 2 for the smoking group (Appendix 7a & 7b).
The method of analysis conducted on the ABPI data was an un-paired T-test. This method is capable of comparing the averages of two independent sample groups. This method has the capacity to calculate any significant differences or similarities between the two groups.

SPSS 12.0.1 was used for statistical analysis in conjunction with Microsoft Excel to create tables and graphs.
4. Results

The aim of this study was to investigate whether smoking influences vascular status as characterised by a low ankle brachial pressure index reading in the younger individual. To determine whether smoking did have a significant impact on the vascular status of the younger smoker, the ABPI’s of ten smokers and ten non-smokers from the podiatry student population were measured and compared. All those who participated in the study satisfied the required criteria for good health as stipulated by the “medical screening questionnaire”. All participants were between 18-35 years of age.

Table 1: Data Collection Table

<table>
<thead>
<tr>
<th>Participant number (Non-smoking group)</th>
<th>ABPI Reading</th>
<th>Participant Number (smoking group)</th>
<th>ABPI Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.10</td>
<td>11</td>
<td>1.12</td>
</tr>
<tr>
<td>2</td>
<td>1.15</td>
<td>12</td>
<td>1.01</td>
</tr>
<tr>
<td>3</td>
<td>1.13</td>
<td>13</td>
<td>1.04</td>
</tr>
<tr>
<td>4</td>
<td><strong>0.94</strong></td>
<td>14</td>
<td><strong>0.92</strong></td>
</tr>
<tr>
<td>5</td>
<td>1.21</td>
<td>15</td>
<td><strong>0.94</strong></td>
</tr>
<tr>
<td>6</td>
<td>1.03</td>
<td>16</td>
<td>1.01</td>
</tr>
<tr>
<td>7</td>
<td>1.02</td>
<td>17</td>
<td>1.04</td>
</tr>
<tr>
<td>8</td>
<td>1.16</td>
<td>18</td>
<td>1.0</td>
</tr>
<tr>
<td>9</td>
<td>1.10</td>
<td>19</td>
<td><strong>0.81</strong></td>
</tr>
<tr>
<td>10</td>
<td><strong>0.89</strong></td>
<td>20</td>
<td>1.02</td>
</tr>
<tr>
<td>Mean Average:</td>
<td>1.07</td>
<td>Mean Average:</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Abnormal readings represented in **Bold**

The gender ratios were almost equal, with the smoking group consisting of 5 females and 5 males and the non-smoking group consisting of 6 females and 4 males. 19 participants during the study reported that they were not taking any prescription medications (with the exclusion of the contraceptive pill), 1 participant belonging to the “smoking group” was currently being prescribed 50mcg Levothyroxine daily.
As previously stated the criteria for normalcy regarding the ABPI reading, was considered at a figure equal to or above one (Wild et al 2006). Any reading of less than one may not indicate peripheral vascular disease but is an indication that arterial changes have occurred (Wild et al 2006).

Any reading above 1.3 would be regarded with suspicion, on the basis that readings of this value occurs only in calcified arteries of diabetes sufferers or when equipment/operator error has occurred. Readings between 1 and 1.3 were considered “normal”. This study set out to determine whether smoking had an effect on ABPI, the extent of the effect was not analysed (Weitz et al 1996). All readings measured in this study were below 1.3.

Graph 1: ABPI distribution scores of smokers and non-smokers

- 16 -
The smoking group sample had a lower average ABPI reading (0.99) compared to the non-smoking group sample (1.07). The smoking group had a standard deviation (SD) of 0.8399 and the smoking group has an SD of 0.101.

As evident in graph 1 the “smoking participant’s” ABPI readings generally appear lower than those in the “non-smoking” participant group.

**Table 2: normal & abnormal ABPI per group**

<table>
<thead>
<tr>
<th></th>
<th>Abnormal ABPI</th>
<th>Normal ABPI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smokers</strong></td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td><strong>Non-Smokers</strong></td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

The lowest ABPI reading was 0.81 and was obtained from a female participant belonging to the smoking group. This participant was in the 31-35 age group and currently smoking 20+ cigarettes daily. She has been actively smoking for 10 years or more.

The participant information tables (appendix 7a & 7b) provide a breakdown of data collected from each individual volunteer regarding their age group, sex, medical status, the number of cigarettes they smoke and the time duration in which they have smoked.
In total five “abnormal” readings were obtained as characterised by being an ABPI reading of less than 1. Three of these readings were taken from the smoking sample and two from the non-smoking sample.

The mean difference between the two groups does indicate that overall the average ABPI of the smokers is less than that of the non-smokers. This however does not provide enough evidence to suggest that a significant difference exists between the two groups.

To determine whether a significant difference between the two groups was evident, an unpaired t-test was calculated using the statistical programme SPSS 12.0.1.

The un-paired t-test is used to calculate the mean differences between two independent sample populations, in this instance the smoking sample and the non-smoking sample (Rowntree 1991).

**Group Statistics**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABPI 1.00</td>
<td>10</td>
<td>1.0730</td>
<td>.10155</td>
<td>.03211</td>
</tr>
<tr>
<td>ABPI 2.00</td>
<td>10</td>
<td>.9910</td>
<td>.08399</td>
<td>.02656</td>
</tr>
</tbody>
</table>

SPSS 12.0.1 first configured descriptive statistics which highlight useful pieces of data for the calculation of significance. Note the mean values in bold.

Statistical significance was investigated using a p-value (probability-value) of 0.05 which has become a conventional figure used in medical research (Campbell & Machin 1989).
**Independent Samples Test**

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>A</td>
<td>.828</td>
<td>.375</td>
</tr>
<tr>
<td>B</td>
<td>.828</td>
<td>.375</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The independent samples test table contains an array of numerical data concerning the relationship between the two independent measured groups.

The “sig. (2-tailed)” column contains the calculated data relating to the significance of the study. In this case the significance value of 0.065 is greater than the 0.05 p-value stated earlier. A value of less than 0.05 is required for the result to be considered significant.

Based on these values the data suggests that there was no “significant” difference between the smoking and non-smoking groups regarding ABPI levels.
5. Discussion

The purpose of this research was to determine whether the effects of smoking in the younger individual aged 18-35, was causing a deleterious impairment on lower limb vascular health as characterised by a reduced ABPI reading.

Research highlighted in the literature review has suggested that the arterial system can be adversely affected in the short term and by low dose levels of cigarette inhalation (Kool et al 1993).

The initial hypothesis predicted that the younger smokers would have a greater incidence of arterial insufficiency in comparison to the younger non-smokers. The results formulated did not support the hypothesis. Statistical analysis of the non-smoking and smoking groups revealed no significant difference between the two samples, therefore rejecting the hypothesis underpinning this research study.

The study was predisposed to many variables that may have influenced the end result, this discussion will highlight some of these areas whilst considering their implications to this study and the requirement for further research.

5.1 Smoking and Peripheral Vascular Insufficiency

In total five participants presented with “arterial insufficiency” as characterised by an ABPI of less than 1. Two of these participants were non-smoking and the remaining three were smokers. The lowest ABPI reading of 0.81 was obtained from the heaviest and most long term smoker in the experiment. Tell et al (1989) cited in Howard et al (1998) found that the
progression of atherosclerosis was proportional to the duration and volume of cigarettes smoked and not dependant on the current smoking status. Three of the longer term and heavier smokers in the study however did appear to have a normal ABPI signifying no arterial insufficiency. Despite the findings cigarette smoking is still a very important factor in causing physiological, structural and functional alterations to the cardiovascular system leading to the development of peripheral arterial insufficiency and possibly disease (Holbrook (1984), cited in Osuka et al 2001).

The extent of damage induced by cigarette smoking to the cardiovascular system in the short term is an area where research seems to be lacking, especially when previous research has linked short term cigarette exposure to physiological impairment and damage (Kool et al 1993).

5.2 Reliability of the Ankle Brachial Pressure Index

The ABPI method used in this study was chosen on the basis of practicality and its resource implications. Other methods for measuring the ABPI may have provided a more accurate and valid result for example Marshall (2004) recognises the importance of using both arms and both ankles when making an ABPI calculation, deriving at a separate ABPI figure for each limb. Past researchers, including Leng et al (1996) have taken bi-lateral ABPI’s and used the lowest readings obtained from the left or right leg as an indication of vascular status.

Jelinek & Austin (2006) compared three common approaches used in measuring and calculating the ABPI and reported a variation in test results for each measured participant. This study used a randomly selected leg which could have missed arterial changes in the non-
selected leg. Peripheral arterial changes can occur unilaterally and there can be a considerable difference in the arterial supply and functioning of each leg (Burns 2003).

Each participant was only measured once, again due to time restrictions and the participant’s availability. Increased reliability would have been gained by measuring each participant on three separate occasions at different intervals and calculating a mean score for their ABPI’s. To provide a more accurate picture of each participant’s overall vascular state, the measurements and analysis of both left and right legs would have provided more depth to this study (Fisher et al 1996).

The methodology required each participant to rest in a supine position for 10 minutes prior to measurement taking. This is a contested area as different author’s state different resting times and some place no mention of any resting times at all. Hislop (1997) considers 5 minutes supine to be an adequate enough time for the blood pressure to stabilise, whilst Cantwell-Gab (1996) claim that a supine position of 20 must be undertaken to achieve an accurate ABPI.

During this study achieving the required 10 minute rest for each participant was difficult. Some participants had limited time due to clinical duties and other commitments, consequently influencing their level of ease, state of relaxation and physiological blood pressure possibly causing an inaccurate representation of their true ABPI.

The ABPI method did present some difficulties, most of which were outside the experimenters control. Experience and practice of using this method inside a well controlled environment is necessary to deliver the most accurate and reliable readings (Bhargava & Greiss 2006).
5.3 Limitations of research and future research

Limitations are inescapable and exist throughout all aspects of research even at the highest level. The ability to recognise and reflect upon these limitations is essential in generating an objective and critical approach (Armitage et al 2001).

The primary limitation for this study was the sample population, consisting of podiatry students. A total of 20 students were used, divided into two groups. This sample is relatively small and arguably not a fair representation of the population in general, an opportunistic sampling method was used which also is susceptible to experiment bias and not as valid as a random sampling method (Campbell & Machin 1989). A larger sample size would have increased the reliability and validity of the results. Many research studies however have also used a small sample size and produced highly regarded and valid findings (Kerry & Bland 1998).

Participants were selected on the basis of satisfying the criteria set by the medical screening questionnaire, the ten non-smoking participants were selected by their confirmation that they did not currently smoke. The questionnaire failed to detail whether the participants were ex-smokers and if so, when they gave up. If a non-smoking participant had only recently given up smoking their physiological arterial condition is likely to be different from that of a person who has never smoked, thus perhaps providing a false indication of their true “non-smoking” status (Bergstrom 2000).

The medical screening questionnaire set out to exclude those that are at an increased risk of abnormal ABPIs, by implementing criteria for good health. It did not however take the body mass index (BMI) of the participants into consideration which may have been an important
factor. Planas et al (2001) discovered a clear correlation between an elevated BMI and an increased incidence of PAD, to have avoided this confounding variable participant’s with a BMI within the normal healthy range should have been selected.

Intra-reliability was also an issue in the “smoking group” were variations existed in the quantity of cigarettes smoked and the duration in which they smoked. Details of the cigarette brand may also have provided valuable data, cigarette characteristics especially nicotine and tar yields differ considerably from brand to brand (Clark et al 1998). Other variables including inhalation depth, puff frequency and smoking environment can also influence levels of nicotine exposure (Patterson et al 1998). This study also failed to establish the non-smoking participant’s potential involvement in passive smoking. A non-smoking person is still capable of suffering from the adverse effects of cigarette smoke exposure (Correa et al 1983).

The discussed weaknesses could be remedied by conducting further research using a larger more representative population sample and implementing stringent controls and criteria as discussed previously. Additional non-invasive measurement tools, such as the “Transcutaneous oxygen pressure measurement” would also compliment the ABPI procedure in detecting peripheral arterial insufficiency.
6. Conclusion

This research project was conducted to investigate the effects of cigarette smoking on the peripheral vascular status as characterised by a lower ABPI in the younger individual, aged 18-35.

The initial hypothesis predicted a small degree of arterial insufficiency as indicated by the ABPI, amongst the smoking sample compared to the non-smoking sample, based on current literature that short term and low dose cigarette exposure can alter arterial functioning.

To determine whether a significant difference between the two groups was evident, an unpaired t-test was calculated using the statistical programme SPSS 12.0.1.

Results indicated that there was no significant difference between the smoking and non-smoking groups regarding ABPI levels. Research findings may have been influenced by various limitations previously discussed. More control over limitations is required to improve the validity and outcomes of future research.

If future research does detect vascular impairment in the younger smoker, such findings would provide health promoters with further deterrent factors and support them in their effort to promote healthful behaviour and encourage smoking cessation.
7. References.


Futterman, (2002). Peripheral arterial disease is only the tip of the atherosclerotic iceberg. 


from http://www.ingentaconnect.com/content/els/art01038;jsessionid=61o5w2nm7n54.alice (Accessed 12/03/2008).


8. Bibliography.


Appendices.
Appendix 1

ABPI variation in “normal” values

<table>
<thead>
<tr>
<th>Authors/Source</th>
<th>Normal Value</th>
<th>Arterial changes/disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowden et al 2005</td>
<td>&gt;1.0</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>Zierler 2001</td>
<td>1.1</td>
<td>&gt;1.0</td>
</tr>
<tr>
<td>Benchimol et al 2004</td>
<td>&gt;0.9</td>
<td>0.75-0.9</td>
</tr>
<tr>
<td>Mc Dermott 2003</td>
<td>0.9-1.5</td>
<td>&gt;0.9</td>
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</table>
Appendix 2

Participant Information Sheet

I appreciate your participation in this research project.

I am undertaking this research project as a requirement for successfully completing my BSc (Hons) Podiatry degree.

Project title: The effects of cigarette smoking on lower limb circulation in young adults- a comparison between smokers and non-smokers aged 18-35.

After completing your medical screening questionnaire I will contact you to discuss whether you are suitable for the study.

The study involves measuring the blood pressure in your arms and ankles. The technique used is considered to be safe and is painless. The measurements will be carried out on three separate occasions at weekly intervals.

Each occasion should not take more than 20 minutes to complete.

Remember that all the information gathered in the investigation remains confidential.

I am more than happy to answer any questions you have with regards to the study.

Thank you.
Jaimangal, Jonathan  
BSc (Hons) Podiatry  
Cardiff School of Health Sciences  
Llandaf Campus  
Western Avenue  
Cardiff CF5 2YB

Dear Applicant

Re: Application for Ethical Approval

The effects of cigarette smoking on lower limb circulation in young adults a comparison between smoker and non-smokers aged 18-35.

Your research project proposal, as shown above, was amongst those considered at the meeting of the Health Care & Psychology Ethics Panel on 12/14/2007.

I am pleased to inform you that your application for ethical approval was APPROVED subject to the conditions listed below – please read carefully.

Conditions of approval

That any changes in connection to the proposal as approved, are referred to the Panel.

That any untoward incident which occurs in connection with this proposal should be reported back to the Panel without delay.

Yours sincerely

[Signature]

Dr T Alwyn, Reader  
Chair of Department of Health Care and Psychology Ethics Panel  
Cardiff School of Health Sciences  
Llandaf Campus  
Western Avenue  
Cardiff CF5 2YB

Tel: 029 20417126  
E-mail: taiwyn@uwic.ac.uk

Cc: Evans, Jeff

PLEASE RETAIN THIS LETTER FOR REFERENCE
Appendix 4

Medical Screening questionnaire for eligible participation

Project title: The effects of cigarette smoking on lower limb circulation in young adults- a comparison between smokers and non-smokers aged 18-35.

Thank you for volunteering to participate in this study. To make sure you are a suitable candidate for this study, please complete the following medical screening questions. If you are unsure of any question please ask.

All this information will be kept confidential.

1. Which age group do you belong to? (please circle) 18-25 26-30 31-35 36-40 40+

2. Do you smoke cigarettes? YES / NO

   If answered YES how many cigarettes do you smoke per day?

   Less than 5 5-10 11-20 20+

   How long have you been smoking for? Less than 2 years 2-5 yrs 6-10 yrs 10+yrs

4. What is your sex? Male / Female

5. Are you pregnant, or have you had a baby in the last 6 months? YES / NO

6. Are you currently taking any medication/s? YES / NO

   If answered YES, Please give details........................................................................................................

Do you suffer from any of the following?

7. Diabetes YES / NO

8. Peripheral vascular disease YES / NO

9. Heart failure YES / NO

10. Hypotension (low blood pressure) YES / NO

11. Hypertension (high blood pressure) YES / NO

12. Varicose veins YES / NO

Thank you for your time.

Participant number: [ ] [ ] (For experimenters use only)
Appendix 5

Consent Form

Title of Project: The effects of cigarette smoking on lower limb circulation in young adults- a comparison between smokers and non-smokers aged 18-35.

- I have had the procedure of the study explained to me.

- I have completed the medical screening questionnaire.

- I understand that there will be no potential risks to me resulting from my participation in the research.

- I have had the opportunity to ask any questions regarding my participation in the research.

- I understand the finding may be published and presented but my name will remain anonymous and my involvement in the study will be completely confidential.

- I understand that I am free to withdraw my consent and end my participation at any time during the study without any consequence.

- I agree to take part in this study

Signed.................................................. Date..........................

Name in BLOCK capitals..................................................
**Appendix 6**

Ankle brachial pressure index calculation sheet

Ankle-Brachial Pressures

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<td>mmHg</td>
<td>mmHg</td>
<td></td>
</tr>
<tr>
<td>(use average arm pressure to calculate ABI)</td>
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Ankle from Randomly selected leg

<p>| | |</p>
<table>
<thead>
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<td>mmHg</td>
</tr>
<tr>
<td>Index</td>
<td></td>
</tr>
<tr>
<td>Posterior tibial</td>
<td>mmHg</td>
</tr>
<tr>
<td>Index</td>
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**Calculation of ABPI:**

Average ankle systolic pressure (from dorsalis pedis and posterior tibial)Average brachial systolic pressure (average obtained from both arms)
<table>
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<th>Participant Number</th>
<th>Age</th>
<th>Sex</th>
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<th>Duration of smoking</th>
<th>Medications</th>
<th>Medical conditions</th>
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Mean Ave: 1.07

Varicose veins:
- Participant 1: 1.15
- Participant 2: 1.13
- Participant 3: 1.11

1.11 0.94 1.10
### Appendix 7 b)

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<tr>
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<td>1.01</td>
<td>1.04</td>
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Smoking participant information table