By Prof. Wilna Oldewage-Theron and Abdulkadir Egal

THE POSITIVE EFFECTS

of soya bean on the blood lipid profile of women

A pilot study from QwaQwa

Cardiovascular disease (CVD) is a group of heart and blood vessel conditions, including stroke and heart attacks. CVD is currently responsible for 17% of all deaths in South Africa and it is estimated that 5,5 million South Africans older than 30 years are at risk of developing CVD. This could be attributed to raised total serum lipid (cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride) levels, among other factors.

In view of the crucial role of elevated levels of blood lipids, especially LDL-cholesterol, in the formation of atherosclerosis, dietary and therapeutic approaches to the treatment and prevention of CVD are very relevant for scientific and public health purposes. Lipid-lowering medicines are effective, but are usually accompanied by severe side-effects.

Epidemiological and experimental evidence as well as clinical trials have confirmed positive correlations between lifestyle and dietary factors related to blood lipid levels. Many studies have confirmed that low blood levels of LDL-cholesterol can predict the incidence of CVD and LDL-cholesterol therapy reduces CVD risk.

Strong relationship

On the other hand, HDL-cholesterol also has a strong relationship with CVD, as increased HDL-cholesterol levels guard against CVD. Studies have shown that soya protein can decrease total serum cholesterol, LDL-cholesterol and total serum triglyceride levels as well as mortality rates from CVD. Moreover, a meta-analysis demonstrated that soya isoflavones have LDL-cholesterol-lowering effects.

As a result of the health benefits of soya protein, specifically the reported cholesterol-lowering function, the objective of this study was to compare the long-term effect (18 months) of at least 40g daily whole-bean soya consumption, consisting of 15g soya protein, on the blood lipid levels of hypercholesterolemic (high blood cholesterol levels) and normo-cholesterolemic (NC, normal blood cholesterol levels) freely living women in peri-urban QwaQwa.

Study method and sample

The study protocol was approved by the University of the Witwatersrand's Medical Ethics Committee for Research on Human Beings (M080931) and was conducted between March 2008 and November 2012. A total of 86 respondents were needed to obtain a statistically representative sample. Women were randomly selected from three tribes by the local community leader.

A baseline survey was conducted in March 2008. A household soya bean gardening programme was implemented in 2009 and soya bean recipes were developed and tested for sensory acceptability in 2009 to 2010.

A total of 90 women were randomly recruited for the intervention study. Soaked (> 8 hours), minced whole soya beans were incorporated into 20 household recipes most frequently prepared in QwaQwa. Skills training included teaching the women how to prepare the soya bean recipes, containing 40g of whole soya beans per person per day, and how to include the recipes in the household menu planning in 2010.

> **Trials have confirmed positive correlations between lifestyle and dietary factors related to blood lipid levels.**

The soya bean consumption intervention was undertaken over 18 months during 2011 and 2012. The researchers visited the women every month to measure compliance, checking

on the availability of soya beans and discussing problems regarding soya bean recipe preparation and side-effects. Dietary intake measurements were done and blood was drawn one week before and one week after the 18-month period. The procedures for data collection and analysis were done according to standardised scientific and statistical guidelines.

The results

The participants had a mean±standard deviation (SD) age of 46,5±12,9 years. The results show that 40% (n = 36) of the women were hypercholesterolemic based on LDL-cholesterol. The mean±SD age of the hypercholesterolemic group was statistically significantly (p = 0,038) higher (50,0±13,3 years) than the NC group (44,2±12,3 years). No statistically significant differences existed between the height, weight and body mass index (BMI) of the hypercholesterolemic and NC groups. In both groups, the mean BMI indicated the prevalence of obesity in these women.

Although no statistically significant changes were observed in BMI after the intervention, the prevalence of overweight in the hypercholesterolemic group was reduced from 36,1% at baseline to 27,8% at follow-up. No changes were observed in overweight of the NC group. In both groups, the prevalence of obesity increased from baseline to follow-up, but was not significant (*Figure 1*).

At follow-up, the hypercholesterolemic group had significantly improved HDL-cholesterol (p = 0,000) and total serum triglyceride (p = 0,000) levels, but with significantly increased total serum cholesterol (p = 0,013) and decreased LDL-cholesterol (p = 0,032) levels. A similar trend was observed in the NC group, however, no significantly improved total serum triglyceride values were observed.

Both groups showed abnormal mean values for all the lipid parameters at follow-up, except for the LDL-cholesterol levels in the NC group, with no statistically significant differences between the two groups. The HDL:LDL ratio is, however, a better indicator of CVD risk than the individual HDL- and LDL-cholesterol levels. The HDL:LDL ratio improved in both groups, but was only significant (p = 0,027) in the hypercholesterolemic group at follow-up. In both groups, the HDL:LDL ratio was still lower than the recommended >0,4.

Both groups had low macronutrient intakes, except for carbohydrates, at baseline and follow-up when compared to the estimated average requirements (EAR). No significant differences in macronutrient intakes were observed between the groups, except for a significantly (p = 0,032) higher dietary cholesterol intake in the hypercholesterolemic group at baseline and follow-up.

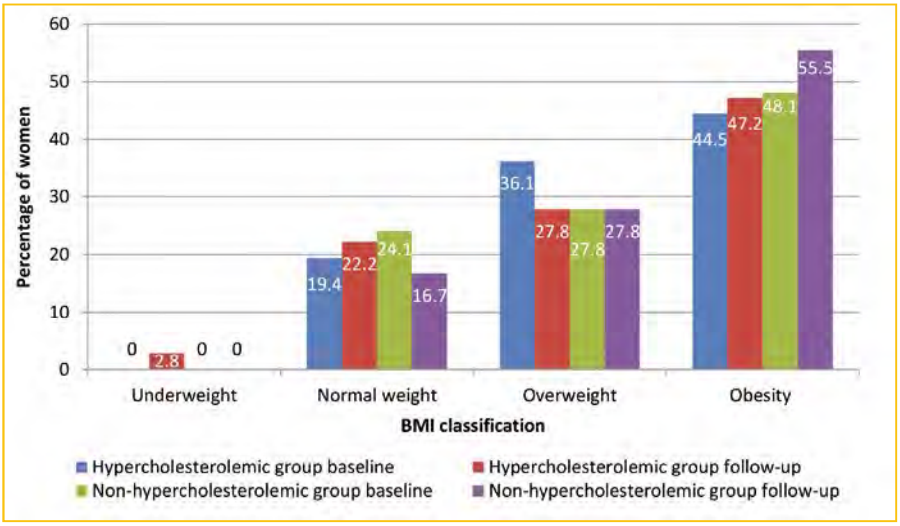
The total fat intake showed low intakes of less than 30% of total energy intake in both groups at baseline, but the NC group showed an improved fat intake at follow-up. According to the guidelines for the prevention of chronic disease, all the fatty acid and linoleic acid intakes recorded percentages in line with the recommendations for both groups, whereas linoleic acid intake percentages were much lower than the recommended goal of 0,5 to 2% in both groups at both baseline and follow-up.

In both groups, the total energy intake improved significantly from 3 772 to 4 829kJ (p = 0,007) and 3 524 to 5 208kJ (p = 0,013) for the hypercholesterolemic and NC group at follow-up respectively. No significant increase in total protein was observed in both groups, but the hypercholesterolemic group showed a significantly (p = 0,000) higher plant protein intake at follow-up, whereas the NC group showed a significantly (p = 0,046) higher total fat intake. In both groups the carbohydrate intake showed a significantly higher intake at follow-up when compared to baseline.

The Pearson correlation analyses revealed that age was significantly and positively co-related to total serum cholesterol at baseline (r = 0,305, p = 0,003) and follow-up (r = 0,282, p = 0,007), as well as cholesterol (r = 0,257, p = 0,014) at follow-up. A significant (p<0,05) positive association existed between the total energy intake and all macronutrient intakes at baseline and follow-up.

No significant relationships existed between macronutrient or fatty acid intakes and serum lipid parameters at baseline. However, at follow-up a significant negative relationship existed between LDL-cholesterol and total protein intake (r = -0,283, p = 0,036), saturated fatty acid (r = -0,287, p = 0,034), mono-unsaturated fatty acid (r = -0,318, p = 0,018) and linoleic acid (r = -0,285, p = 0,035) intakes.

Figure 1: BMI classification of the women before and after the intervention.



Cholesterol-lowering effect

Research has proved that soya protein consumption can reduce total serum cholesterol levels as well as LDL-cholesterol levels and increase HDL-cholesterol levels. As a result, the Food and Drug Administration (FDA) of the United States has recommend that 25g of soya protein should be consumed daily for a cholesterol-lowering effect. Furthermore, favourable blood lipid concentrations can be achieved

if at least 30g of soya protein is consumed daily for at least six weeks.

Conflicting reports exist in the literature regarding the effect of soya consumption on serum lipid levels. The results of this study showed that in both hypercholesterolemic and NC women, the HDL-cholesterol levels improved significantly after the intervention in both groups, but it was still lower than the recommended cut-off point of >1,68mmol/ℓ.

This was consistent with the findings of Borodin et al. and Sacks aet al., who found a significant increase in HDL-cholesterol levels of NC adults. The LDL-cholesterol levels were significantly lower in both groups at follow-up, however, the total serum cholesterol levels were raised by 5,9% in the hypercholesterolemic women compared to 39,6% in the NC women respectively.

These findings were not consistent with a meta-analysis of 38 studies that found that a daily consumption of 47g soya protein, mainly in adults with dyslipidaemia, resulted in an average reduction of 9,3% and 12,9% in total serum cholesterol and LDL-cholesterol respectively. Most of the studies included in the meta-analysis measured the short-term effect (≤4 weeks).

Positive effect

This study is the first to report on a comparison of the long-term effect of daily consumption of 15g soya protein on serum lipid markers in low-income black women, with and without hypercholesterolemia in South Africa. The inability of this study to prove a positive effect on total cholesterol levels after a long-term soya bean supplementation/consumption period, was consistent with another long-term (24 weeks) study in hypercholesterolemic adults. LDL-cholesterol, however, was significantly reduced in both groups at follow-up.

Total serum cholesterol can be influenced by changes in increased dietary cholesterol intakes, endogenous cholesterol synthesis, efficiency of cholesterol absorption or through other dietary intake factors. In this study, both groups showed low cholesterol intakes at baseline and follow-up, although, the NC women had a significant higher intake of dietary cholesterol at follow-up when compared with baseline. However, no positive significant relationship between dietary cholesterol intake and total serum cholesterol was established in this group of women.

Furthermore, the dietary intake of the women in this study showed very low macronutrient intakes, specifically fibre. The effect of dietary fibre, especially whole-grain fibre, on cardiometabolic health has been established and it has been proved that dietary fibre can lower total serum triglyceride and LDL-cholesterol levels.

Cholesterol levels

Another dietary factor that is associated with total serum cholesterol and LDL-cholesterol levels is dietary SFA intakes. In this study both groups consumed less SFA than the World Health Organisation (WHO) recommended cut-off point of 10% of total energy intake. However, no positive significant relationship between dietary fibre or SFA intake and serum, total serum cholesterol and LDL-cholesterol could be established in this study, possibly because of the low dietary intake levels of these nutrients by both groups.

Although the total dietary fat intake for both groups was low, the dietary fatty acid intakes of the women in this study met the recommended guidelines, except for low linoleic acid intakes in both groups. The main sources of linoleic acid in the diet include vegetable oils such as sunflower oil, soya bean and maize oil, nuts and seeds. These are usually more available than the food sources of linoleic acid, including walnuts, linseed and rapeseed oil. This finding is consistent with another study among low-income black women in South Africa.

Both groups showed abnormal mean values for all the lipid parameters at follow-up, with no statistically significant differences between the two groups. The HDL:LDL ratio improved in both groups, but it was only significant in the hypercholesterolemic group. In both groups the HDL:LDL ratio was still lower than the recommended >0,4 and thus this group of women is at risk of CVD. These findings are consistent with a study conducted in a similar community in the Vaal region.

Beneficial effect

Dyslipidaemia, hypertension and obesity are well-known risk factors for CVD. In this study, 36% of the women presented with hypercholesterolemia, which was higher than the national prevalence, and 31,1% and 46,6% were overweight and obese respectively at baseline. Research also found that the mean total serum cholesterol concentrations increase with age, peaking among those from 55 to 64 years. Total serum cholesterol levels were positively significantly associated with age in this group of dyslipidaemia women.

It can be concluded that hypercholesterolemia and obesity were prevalent among this group of women. Although research has proved that soya protein has a beneficial effect on total serum cholesterol and LDL-cholesterol, the daily consumption of 40g of whole soya bean, equivalent to 15g soya protein, had no significant positive effect on total serum cholesterol, but had a beneficial effect on LDL-cholesterol of the hypercholesterolemic and NC women in QwaQwa. The HDL:LDL ratio was also improved in the hypercholesterolemic group, thus reducing the risk for CVD. It was thus proven that soya bean consumption has a beneficial effect on hypercholesterolemia in women.

Soya bean is a source of good quality protein and is often used in low-income households as a replacement for other more expensive protein sources. The use of soya bean should not be discontinued and further research is recommended to study the effect of daily soya bean consumption on hypertension, obesity and metabolic syndrome, also prevalent in this group of women. Research should also aim to determine the optimal soya protein dosage for the most favourable effect on these risk factors for CVD.

Wilna Oldewage-Theron is from the Centre of Sustainable Livelihoods at the Faculty of Human Sciences of the Vaal University of Technology and Abdulkadir Egal is from the Department of Nutritional Sciences, College of Human Sciences, Texas Tech University. The authors acknowledge SANPAD and the Vaal University of Technology for funding, as well as the women participating in the study and the fieldworkers for their assistance.