# New Zealand nuclear test veterans: a summary of expert reviews of three studies

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## Executive summary

- Six experts reviewed three scientific studies assessing the psychological impact and long-term radiation damage suffered by New Zealand veterans involved in Operation Grapple.
- The psychological impact study shows a detriment on psychological and well being measures in the exposed veterans compared to a control group. However due to the way the two groups of men were selected, it is not possible to conclude that these differences are solely due to radiation exposure.
- The sister chromatid study showed a small but significant increase in the frequency of chromosome abnormalities among exposed veterans. The impact on health and well being of this small difference cannot be determined.
- One of three tests in the cytogenetic study showed statistically significant elevated frequencies of some chromosomal anomalies in exposed veterans. While this may indicate long-term damage from radiation exposure, the actual health implications of these chromosomal changes are not certain.
- The expert review concludes that increased medical monitoring of the exposed veterans may be warranted, but there is no recommendation for enhanced medical surveillance of the veterans' children.

## Introduction

Three recent scientific studies have been conducted to assess the psychological impact and long-term radiation damage suffered by New Zealand veterans who were involved in Operation Grapple in 1957. All three studies were carried out on the same cohort of veterans. In each study, the results from the exposed men were compared with those from a group of men who had not knowingly been exposed to radiation.

The three studies were, "New Zealand nuclear test veterans' study: a pilot project (psychological impact)" (Podd et al., 2005); "New Zealand nuclear test veterans' study: a pilot project (sister chromatid exchange)" (Rowland et al., 2005) and "New Zealand nuclear test veterans' study – a cytogenetic analysis" (Rowland et al., 2007).

The aim of the psychological impact study was to assess the psychological well being of the group of NZ veterans exposed to nuclear radiation compared to the control population. The aims of the sister chromatid exchange study and the cytogenetic analysis were to investigate the delayed effects of exposure to ionizing radiation by looking at chromosome abnormalities.

The study reports were provided to Veterans' Affairs New Zealand, and in turn were reviewed by the Ministerial Advisory Group on Veterans Health. The Ministerial Advisory Group commissioned six experts in various fields to review the reports independently and assess their scientific validity. Two experts reviewed the psychological impact study report (Podd et al., 2005): Professor Mark Creamer, Director of the Australian Centre for Posttraumatic Mental Health and Keith Petrie, Professor of Health Psychology at the University of Auckland. Four experts reviewed the sister chromatid study report (Rowland et al. 2005): Stephen Robertson, Professor of Paediatric Genetics, University of Otago; Yuri Debrova, Professor of Genetics, University of Leicester; Ian Morrison, Professor of Pathology, University of Otago and Dr John Dockerty, Epidemiologist and Public Health Physician. Three of these experts (Prof Debrova, Prof Morrison and Dr Dockerty) reviewed the cytogenetic analysis (Rowland et al., 2007).

The aim of this short report is to summarise the expert reviews.

## Expert review

### *Observations common to all three studies*

Three of six reviewers stated that, in their opinion, the studies and analyses were competently carried out. All six reviewers expressed some concerns regarding the methods used in the studies.

The same 50 exposed veterans and 50 control men (the control group) provided data for all three studies (questionnaires for the psychological impact study and blood samples for the sister chromatid and cytogenetic studies). There is concern regarding the choice of both the exposed and the control group in all three studies. While the men in the control group were matched to the exposed veterans by age, there are differences in the two populations. Ideally the researchers should have chosen a random sample of exposed men and compared them to a random sample of naval personnel who were serving

at the same time but who were not involved in Operation Grapple. This would mean that the men in both groups would be similar except for their exposure to radiation. The differences found in the two populations could then potentially be attributed to the effects of radiation. For the studies the exposed group were self-selected and not randomly chosen. This means that veterans with health problems or other biases may have been more likely to volunteer than those in good health. The control group men were recruited through the RSA and through personal contacts of the exposed men. There is an extremely high potential for error in that the exposed men may have (consciously or unconsciously) chosen men for the control group who they felt were in better health than them. The studies required men in the control group to have had some form of military or police training but were not allowed to be ex-naval personnel. That selection constraint means that men from the control group may have differed from the exposed men in more ways than radiation exposure alone. None of the men (exposed or controls) were allowed to have served in a theatre of war, received radiation or chemotherapy, or have been Air Force aircrew. The researchers were trying to ensure that the only radiation exposure was from Operation Grapple. However, the list of entry criteria for the study means the two groups were not well matched, which makes it very difficult to interpret differences between the two groups. By observation, the exposed veterans had lower levels of education, lower income, and had smoked at higher levels and for longer periods of time than the control group men.

These factors make it extremely difficult to definitively attribute any differences between the two groups to radiation exposure alone.

### *Psychological impact study (Podd et al., 2005)*

The conclusion of the study report states the exposed veterans were more depressed, had poorer perceived physical and mental health, poorer perceived memory and more long-term health problems than the men in the control group. The authors concluded that many of the exposed men were suffering from chronic stress.

The study shows a clear detriment on psychological and well being measures in the exposed men. However, because of the way both groups of men were chosen, it is not possible to conclude that these differences are solely due to differences in radiation exposure. This does not mean that there have been no adverse effects of the radiation, merely that this research does not prove the existence of these effects. A head to head study evaluating the health of random samples of exposed and non-exposed naval personnel may provide more scientifically robust results.

### *Sister chromatid study (Rowland et al. 2005)*

Chromosomes are long strings of genetic information, which can consist of thousands — or hundreds of thousands — of individual genes. Sister chromatids are identical joined pairs of a single chromosome. Sister chromatid exchange is a transfer of similar segments of genetic material between the sister chromatids; this exchange increases as a result of chromosomal fragility due to genetic or environmental factors such as ultraviolet or ionizing radiation. The sister chromatid study investigated these exchanges in exposed veterans compared to the control group.

The study report finds that the exposed veterans show a statistically significantly increased degree of sister chromatid exchange compared to men in the control group. The authors of the report conclude that this indicates significant elevations in chromosomal breakdown; a known consequence of ionizing radiation. The authors feel that there are no confounding factors to explain these findings, other than differences in radiation exposure. They therefore conclude that the damage has been caused by the veterans' exposure to radiation during Operation Grapple.

While one of the expert reviewers (Dubrova) also feels that these results provide strong evidence for the long term effects of radiation exposure on the veterans, the other three experts who reviewed the study do not. All three remaining experts are concerned that sister chromatid exchange is not necessarily the best indicator of exposure to ionizing radiation.

The study has several methodological weaknesses. The results were not adjusted for smoking; the exposed veterans smoked more and for longer than men in the control group. These important differences should have been taken into account by the authors. The sample size of the study is relatively small (50 men in each group) and fewer cells per individual were analysed in the exposed group. One expert reviewer is concerned that the blood samples of the exposed veterans and the control group were taken at different times because sister chromatid test results can vary with the batches of chemicals used.

Regardless of the choice of subjects and the methodological limitations, the experts questioned the significance of the results. The elevation in sister chromatid exchange is significant, but small. The actual clinical significance of the difference is not clear; i.e., the question remains whether such small changes would lead to adverse health effects.

### *Cytogenetic analysis study (Rowland et al., 2007)*

The cytogenetic study used three further tests to assess genetic damage. Two of the tests showed no difference between the groups (the micronucleus assay and the G2 assay) and will not be discussed further. The authors used a multicolour fluorescent in situ hybridization (mFISH) assay. With this test, each pair of chromosomes is stained a different colour; this enables the detection of exchanges or anomalies.

The results of the mFISH assay show an increased rate of stable translocations (i.e., rearrangement of chromosomal material within stable cells) among exposed veterans compared to the control group men. There was a statistically significant increase of 29 translocations per 1000 cells in the exposed veterans compared to 10 translocations per 1000 cells in the control group. The authors state this indicates long-term damage from radiation exposure.

The expert reviewers did not doubt the difference in translocations between the two groups. However, one reviewer was concerned that translocations were only scored in stable cells (complex or unstable cells were not included in the analysis). The reviewer was not entirely convinced that only stable cells would reflect distant past exposure to radiation and wondered if complex and/or unstable cells should have been included in the analysis. Potential limitations of the test were that control group blood

samples may have been taken after those of the exposed group and processed using different batches of chemicals. Furthermore, the analysis splits the results by "never smoked" and "ever smoked", yet the exposed veterans smoked on average about 1.8-fold more units that the control smokers meaning the two "ever smoked" groups are not comparable.

There appears to be an increase in stable translocation among exposed veterans compared to the control group. These findings are interesting and warrant further investigation. However, there is not enough evidence to attribute causality to radiation exposure alone, or to ascertain the seriousness of the findings.

Increased medical monitoring of the exposed veterans may be warranted. However, the reviewers found no evidence that any effects would be inherited. None of the reviewers suggested enhanced medical surveillance of the veterans' children.

## Summary

In all three studies, the poor choice of exposed and control subjects means that it is difficult to understand the reported differences between the groups and therefore to draw conclusions on which decisions can be made.

The psychological impact study shows a clear detriment on psychological and well being measures in the exposed veterans. However, it is not possible to conclude that these differences are solely due to differences in radiation exposure. The sister chromatid study showed a small but significant increase in the frequency of sister chromatid exchange among exposed veterans. It is uncertain what impact on health and well being this small difference would have. One of three tests in the cytogenetic study showed statistically significant elevated frequencies of some chromosomal anomalies in exposed veterans, which may indicate long-term damage from radiation exposure. However, causality cannot be definitively attributed to radiation alone. The actual health consequences or the seriousness of these chromosomal changes are not certain.

Medical monitoring of the exposed veterans may be warranted, but enhanced medical surveillance of the veterans' children is not supported.

## References

Podd et al., 2005. New Zealand nuclear test veterans' study: a pilot project (psychological impact).

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## Expert reviews

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