A New Role for Exercise: Examining the Effects of Physical Activity on Polychlorinated Biphenyl-induced Cardiovascular Disease

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Abstract

Cardiovascular disease is the leading cause of mortality in developed countries. Polychlorinated biphenyls (PCBs) are persistent environmental pollutants that contribute to the initiation of cardiovascular disease. Previous work in our laboratory has examined the potential role of nutrition in modulating the toxicity of PCBs in vascular endothelial cells. We hypothesized that, in addition to nutrition, exercise might also contribute to the initiation of cardiovascular disease. Previous work in our laboratory has demonstrated that regular physical activity could be utilized as a therapeutic approach for the prevention of adverse cardiovascular health effects induced by environmental pollutants such as PCBs.

Experimental Design

All mice at 2 months of age fed standard chow diet

- PCB, Sedentary
- PCB, Exercise
- Control, Sedentary
- Control, Exercise

Exercise increases body weight & lean body mass

Exercise attenuates PCB-induced glucose intolerance

Exercise improves PCB-induced cardiovascular risk factors

Exercise decreases circulating inflammatory markers in the plasma

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References


Conclusions

- Exercise attenuates PCB77-induced glucose intolerance, supporting a protective role for exercise against the development of diabetes.
- Exercise decreases serum blood cholesterol, blood pressure, and circulating proinflammatory cytokines in PCB-treated mice suggesting a potential role as an inexpensive therapeutic therapy against PCB exposure.
- Exercise shows a trend towards protection against PCB77-induced atherosclerosis. A repeated study with a larger sample size may demonstrate protection.

- PCB77 concentrations were not detected in tissues; however, the metabolites were detected in feces. Exercised mice have significantly less PCB metabolites than their sedentary counterparts, suggesting that exercise may increase clearance of PCBs from the body and this may be one of the mechanisms of protection.

Figure 1. Mice were weighed weekly. Values are means +/- SEM. * Significant difference compared with sedentary and exercise groups (p<0.05) starting at week 5 through end of study. Body composition was measured by Echobell for lean body mass and a significant difference was found between the groups at the end of the study and fat mass is not statistically different. (C) Food consumption was monitored weekly. *p<0.05

Figure 2. Blood glucose concentrations were examined in mice administered vehicle or PCB77. Mice were fasted for 6 hours and then given a bolus of glucose (20% D-glucose in saline). Blood collected from the tail was tested for glucose concentration using a handheld glucometer (Freedom Freestyle Lite; Abbott Laboratories, Abbott Park, IL) and blood glucose was quantified at 0-120 min. Total area under the curve (AUC) calculates the area below the observed concentrations. Data are mean +/- SEM and represent 5 mice per treatment. *p<0.001

Figure 3. Plasma samples were tested for choleserterol using a serum cholesterol kit (Wako Chemicals USA, Inc, Richmond, VA) according to manufacturer’s instructions. Results represent mean +/- SEM. # (p<0.001) Blood pressure was measured via the tail-cuff method (Coda). Values are mean +/- SEM.  * (p<0.05)

Figure 4. Plasma samples were tested for MCP-1 (A) and IL-6 (B) using mouse adipokine LINCOplex kit (Linco Research, St. Charles, MO) according to manufacturer’s instructions. Results represent mean +/- SEM. # (p<0.05)

Figure 5. Lesion surface areas were quantified from the aortic root from sedentary or exercised mice administered PCB77. Exercise significantly attenuated lesion surface area on the aortic root in PCB-treated mice. A: Lesion area of aortic sinus sections stained with Oil Red O. B: Oil Red O staining of representative aortic sinus for PCB-treated mice.

Figure 6. PCB77 and its hydroxylated metabolites were measured using a Shimadzu UFLC coupled with an AB Sciex QTRAP 5500 triple quadrupole mass spectrometer in multiple reaction monitoring (MRM) mode. 13C12 PCB 95 and 46-PCB 77 were used as internal standards. The sample injection volume was 15 µl. Data are mean +/- SEM and represent 5 mice per treatment. *p<0.05

Exercised mice have less PCB Metabolite Concentration in Feces

Figure 7. OH-PCB77 Metabolite Concentrations

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