



ALTERNATIVE THERAPIES IN WOMEN'S HEALTH

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Dong Quai: A Review

By Michael D. Rotblatt, MD, PharmD

DONG QUAI (ALSO KNOWN AS DANG GUI, TANG KWEL, OR CHINESE Angelica root) is a popular traditional Chinese medicine, frequently used in formulations for gynecologic disorders. In the United States, it is often labeled simply for “female balance and well being.” Dong quai is used to treat menopausal symptoms, premenstrual syndrome, amenorrhea, and dysmenorrhea, and is also used as a general female tonic.

Source and Identity

Dong quai is a member of the Apiaceae (Umbelliferae) family, which includes parsley, carrots, and parsnips (as well as poison hemlock).¹ Chinese dong quai (*Angelica sinensis*) is the most widely used species. *A. acutiloba* (Japanese dong quai) and *A. gigas* (Korean dong quai) have been used for similar medicinal purposes, but are not as highly regarded in China. *A. archangelica* (European angelica) and *A. atropurpurea* (American angelica) are utilized in Western herbal medicine, and are also used as flavoring agents in foods, desserts, and beverages (including Benedictine). With all *Angelica* species, the roots and rhizomes are the most extensively used parts of the plant.² Only *A. sinensis* (Chinese dong quai) will be discussed here.

Dong Quai in Traditional Chinese Medicine

One of the earliest Chinese herbal writings, Lei Gong's *Treatise on Preparation of Materia Medica* (588 A.D.), described dong quai: "...it is warming to the body, and it is non-poisonous. The root is used medicinally as a strengthener of the heart, lung, and liver meridians; it is a tonic of the blood and promotes blood circulation; it regulates the menstrual cycle and stops menstrual pain; it lubricates the bowel..."³

Chinese women have long used dong quai oral preparations for general health promotion and to treat abnormal menstruation, dysmenorrhea, anemia or “blood deficiency” patterns, and childbirth

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difficulties.¹⁻⁵ Administration by injection (IV, IM, or into acupuncture sites) has also been used by 20th century Chinese physicians to treat pain syndromes, thromboangiitis obliterans, chronic pelvic infections, Raynaud's disease, rheumatoid arthritis, stroke, allergic rhinitis, and many other disorders, although proof of efficacy has not been established.^{3,6,7}

Dosage

The dose of dong quai is usually 4-15 g in many oral formulations.^{1,4,8,9} Like other Chinese medicines, dong quai is traditionally used in combination with many other herbs (usually four or more) due to a belief in synergy and balance of herbal constituents. Because Western medicine focuses on single chemical components, North American consumers can also purchase dong quai as a single herbal preparation that contains about 0.5 g/capsule.

Pharmacology

In the last 50 years, many studies investigating the pharmacologic actions of *A. sinensis* have been published. Dong quai (and a variety of extracts and chemical constituents such as ferulic acid and polysaccharides) demonstrates biologic activity in a wide range of in vitro and animal experiments. (See Table 1 for a summary of some of these pharmacologic studies, drawn primarily

from the Chinese medical literature.) Although these experiments can provide clues for further clinical research, activity in animals may be very different than activity in humans (differences in dose, route of administration, species specificity, etc.).

In the 1950s, two distinct extracts were shown to have contrasting effects on uterine muscle activity in animal experiments with both pregnant and non-pregnant cats, dogs, and rabbits.^{3,6,10} A volatile oil component of dong quai was found to inhibit spontaneous uterine contractions in isolated uteri (less marked effect was seen after intravenous administration in vivo). In contrast, a water-based or alcohol-based component given intravenously strengthened and increased uterine contractions in vivo. A more recent study of ferulic acid, one of the main chemical components of *A. sinensis*, found oral doses of 300 mg/kg to have an inhibitory effect on contractions of the rat uterus.¹¹ Among Chinese practitioners and herbalists searching to scientifically substantiate Traditional Chinese Medicine (TCM), these studies supported their belief that dong quai may help to "normalize" or "correct imbalances" of uterine muscle contractions in women.

Is Dong Quai a Phytoestrogen?

Dong quai is not considered estrogenic in TCM, but modern Western herbalists often ascribe estrogenic effects to this herb. A casual survey of women's health books in a metropolitan bookstore found that nine of 12 sources which discuss dong quai believe that it works either via an herbal estrogen (phytoestrogen) effect or by otherwise regulating female hormones. However, this is probably incorrect. In Chinese pharmacologic studies from several decades ago, no estrogenic effects were seen on vaginal smears of mice, and rodents fed dong quai as 5% of their diet did not develop increased uterine weights.^{3,6} Based on these investigations, Chinese scientists concluded that dong quai was not an estrogenic stimulant.⁶

In a 1998 U.S. study, dong quai was found not to bind to estrogen receptors (ERs) in vitro, nor did it stimulate cell proliferation in ER-positive human breast cancer cells.¹² However, contrasting results were presented by researchers at a March 1998 meeting of the American Association for Cancer Research (as yet unpublished).¹³ Dong quai did bind to estrogen receptors in these in vitro experiments, and adding the herb to the feed of oophorectomized rats also increased uterine weight, again raising the possibility that the herb has an estrogenic effect in vivo.

The only human trial that addressed this question did not find an estrogenic effect. At a Kaiser Permanente

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Table 1
Reported Pharmacologic Effects of Dong Quai or Components*

Actions	Information about Study
Gynecologic (see text):	
Inhibits uterus contractions	Volatile oil component; animals, IV and in utero
Strengthens uterus contractions	Water-soluble component; animals, IV route
Cardiovascular:	
Increases coronary blood flow	Anesthetized dogs, dose = 2 g/kg IV
Decreases myocardial ischemia	Injection, anesthetized animals
Increases myocardial ischemia	Injection, conscious dogs
Anti-arrhythmic activity	Variety of animals, IV route
Decreases blood pressure; vasodilation	Rapid action, short duration; IV route
Decreases atherosclerosis formation	Rats fed dong quai as 5% of diet
Hematology:	
Promotes hematopoiesis	Rats; polysaccharide component
Inhibits platelet aggregation	Rats; 20 g/kg crude drug IV
Increases coagulation time	Rats fed dong quai PO; in vitro test of blood
Decreases blood viscosity and fibrinogen levels; increases PT	Dong quai injected into human patients with "acute ischemic apoplexy"
Decreases thrombus propagation	Rats
Immune System:	
Increases function of macrophages	Mice; SQ and PO routes
Increases IL-2 production	Dong quai and ferulic acid component
Immunosuppressant effect	Rats; inhibits production of antibodies
Miscellaneous:	
Antibacterial effects	Weak in vitro activity against several bacteria
Inhibits experimental liver damage	Variety of animals
Protects against radiation damage	Mice; polysaccharide component
Increases and decreases contractions of intestine and bladder	Dogs, rabbits; IV water-soluble extract
Relaxes bronchial smooth muscle	Guinea pigs; specific chemical constituents
Analgesic	Decreases writhing reaction in mice (similar to salicylate)
*These pharmacologic effects are examples of findings from the Chinese medical literature and do not include all studies.	
Source: Summarized from references 3, 6, 7, 10, 22, 23.	

Medical Center in Oakland, California, Hirata and colleagues studied 71 postmenopausal women with hot flashes in a well-designed, randomized, double-blind, placebo-controlled trial.¹⁴ In this study, subjects were randomized to treatment with a placebo or 4.5 g/d of a standardized dong quai root product (500 mg/capsule; 3 capsules tid) for 24 weeks. Subjects were evaluated for serum hormone concentrations, vaginal cell maturation, endometrial proliferation with transvaginal ultrasonography, and menopausal symptoms with a self-reported diary of hot flashes and a menopausal index score (the Kupperman index). There were no statistically significant differences between the dong quai group and the placebo group in any parameter that was tested. Participants were unable to distinguish between herb and placebo, and both groups noted similar side effects dur-

ing the study. Based on this well-designed study, dong quai (in a dose of 4.5 g/d) does not appear to have any significant estrogenic effects.

Is Dong Quai Clinically Effective?

Dong quai-containing formulas (in combination with other herbs) have been reported to be effective in the Chinese medical literature for dysmenorrhea, amenorrhea, menopausal symptoms, pelvic infections, premenstrual syndrome, hepatitis, COPD, chronic glomerulonephritis, and others.^{5,6,15} Most of these studies rely partially or completely on the TCM theories of diagnosis and treatment, and these studies (usually case series) are methodologically inadequate.

Based on the well-designed trial by Hirata et al, described above, dong quai by itself is no more helpful

than placebo for relieving menopausal symptoms.¹⁴ This study has been criticized by advocates of TCM because traditional Chinese practitioners would never prescribe dong quai alone. The authors of this study are working with TCM practitioners to re-test dong quai in a mixture prescribed according to TCM principles.

Toxicity

Dong quai is not known to have serious side effects. Herbalists often state that it has mild laxative properties, which is most likely based on ancient Chinese writings that it "lubricates the bowel." Based on experiments in animals, Chinese scientists are concerned that dong quai may similarly affect the uterus and blood coagulation of humans, and thus recommend that it be avoided in menorrhagia, early pregnancy, and bleeding disorders.³ In rabbits, large oral doses of dong quai (2 g/kg bid) slightly decreased the prothrombin time (PT) of a single dose of SQ warfarin, but increased the PT in animals that had taken warfarin for several days.¹⁶ Warfarin kinetics were not affected, and the contrasting results of this study are difficult to interpret.

Because dong quai contains furanocoumarins (e.g., psoralen), some feel that users should be cautioned about potential photosensitization (occasionally seen in people who collect plants that contain these chemicals), or even about the potential photocarcinogenic or mutagenic effects of psoralens.¹⁷⁻¹⁹ However, to put this in the proper perspective, these chemicals are also found in many edible plants, such as parsnip, celery, and parsley.^{18,20} Also, coumarins are only slightly soluble in water, so aqueous preparations are relatively safe. Alcohol extracts would be expected to contain larger amounts of coumarin and may be more problematic. Saffrole is another minor chemical component of dong quai that, in high concentrations (such as in sassafras oil), can cause hepatocellular carcinoma in rodents.^{17,20,21} However, saffrole is also reported as a minor component in a variety of common plants and spices, including nutmeg, ginger, and black pepper.²¹

Although injecting the herb or drinking a concentrated extract may have toxic potential, the crude herb and usual extract forms appear to have few if any side effects. There are no documented cases of toxicity from dong quai. Hirata's controlled study did not demonstrate any adverse effects. Although gas, burping, and headache were all reported, the incidence of these symptoms was similar in the placebo group.

Conclusion

Based on long historical use and limited clinical study, dong quai appears to be safe. Beneficial claims

have been based on TCM theory, in vitro and animal experiments, and uncontrolled clinical trials. The only controlled trial to date demonstrated no estrogenic activity and no effect on menopausal symptoms. Its effect on menstrual irregularity has not been tested. The use of dong quai in combination with other herbs (as traditionally used) has not yet been tested in a methodologically adequate clinical trial. For evidence-based practitioners, the question of whether dong quai has any clinical benefits or is effective in traditional combination formulas awaits future controlled clinical investigations. ❖

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Biofeedback and Incontinence

By Adriane Fugh-Berman, MD

PELVIC FLOOR MUSCLE (PFM) EXERCISES AND BIOFEEDBACK are underutilized—although effective—treatments for incontinence. Urinary incontinence is common, especially in elders, affecting 38% of community-dwelling women over the age of 60. Among women, stress incontinence (loss of urine during coughing, sneezing, or physical exertion) is more common than urge incontinence (involuntary urine loss associated with a strong urge to void). Mixed symptoms are common. Besides being a major problem in social settings, health care costs related to incontinence are estimated to be \$16 billion a year.¹

Technique

Biofeedback is “a teaching technique that facilitates learning by providing patients with immediate and observable information about physical performance.”²

In the treatment of incontinence, biofeedback may measure pelvic muscle activity through urethral sphincter pressure and electromyography; circumvaginal muscle manometry and electromyography; and anorectal manometry and electromyography. Detrusor pressure feedback can be measured by cystometry. Feedback on intra-abdominal pressure may be utilized to help patients learn to simultaneously contract pelvic muscles while relaxing abdominal muscles (to avoid putting excess pressure on the bladder).² Theoretically, PFM biofeedback should be more effective for stress incontinence, and detrusor muscle biofeedback should be more effective for urge incontinence, but clinically PFM training or combined biofeedback appears to be helpful in both types.

Kegel reported a high success rate for PFM training for incontinence in 1948.³ Surgery, however, eclipsed Kegel exercises as a treatment, and physical therapies only began to resurface in the 1980s. A number of uncontrolled trials have found a benefit from biofeedback-assisted pelvic muscle exercises for incontinence; only in recent years have better trials been done.

Clinical Trials

Biofeedback may be particularly helpful in urge incontinence. A recent well-designed, double-blind, controlled trial found biofeedback-assisted behavioral treatment superior to conventional drug treatment for urge incontinence.¹ One hundred ninety-seven women aged 55 to 92 were randomized to one of three groups: biofeedback-assisted behavioral treatment, oxybutynin, or placebo.

The biofeedback/behavioral training group went through four sessions. During the first session they were taught to identify and contract pelvic muscles through anorectal biofeedback. Participants were taught “urge strategies” at the second visit (sitting down, relaxing, contracting pelvic muscles repeatedly, and proceeding to the toilet at a normal pace once urgency subsided). At the third visit, combined bladder-sphincter biofeedback was used to help patients learn to contract pelvic muscles against increasing volumes of fluid, during detrusor contraction, and under conditions of increasing urgency. The fourth session was used to review and reinforce home practice.

All patients assigned to oxybutynin began with 2.5 mg tid (half of the usual adult dose); if this was ineffective or if side effects were a problem, dosage adjustments were made between a minimum of 2.5 mg/d and a maximum of 5 mg/d. (Similar adjustments were made with the placebo group.) By starting with a low dose and allowing flexible dosing, this design is more similar

to clinical practice and also maximizes drug compliance, as individualizing dosage would be expected to minimize adverse effects. Placebo dose adjustments are an interesting aspect of this study and would be expected to maximize the beneficial effects of the placebo.

Patients kept bladder diaries; the main outcomes were reduction in the frequency of incontinence episodes and patients' perceptions of improvement and satisfaction with the treatments. The attrition rate was 6.2% in the biofeedback group, 17.9% in the drug treatment group, and 18.5% in the placebo group.

Biofeedback/behavioral training was significantly more effective and more satisfactory to the patients than drug treatment or placebo. Biofeedback resulted in an 80.7% reduction of incontinence episodes, compared to a 68.5% reduction with drug treatment and 39.4% reduction with placebo. More than 96% of patients in the biofeedback group were comfortable enough with their treatment to continue indefinitely, while 14% wanted to change to another treatment. Although drug treatment was effective, only 54.7% stated that they could continue indefinitely and 75.5% stated that they wanted to receive another treatment.

PFM training is effective even on homebound elders. A study of adults over the age of 60 randomized 105 subjects to biofeedback-assisted PFM training or to an untreated control group; the treated group achieved a 75% reduction in urinary accidents compared to a 6.4% reduction in the control group.⁴ Those in the control group then received PFM training. A total of 85 patients completed treatment, achieving a median 73.9% reduction in urinary accidents.

For stress incontinence, PFM exercises are effective, but adding biofeedback to PFM may not result in additional improvement. A systematic review of 11 randomized, controlled trials examining prevention and treatment of stress incontinence with pelvic floor muscle exercises found strong evidence of the efficacy of PFM exercises in reducing the symptoms of stress urinary incontinence.⁵ However, this review found no evidence that PFM exercises with biofeedback are more effective than PFM exercises alone for stress incontinence.

Besides biofeedback, other "aids" to effective PFM exercising include electrical stimulation and vaginal cones, both of which have been used successfully to treat incontinence. Electrical stimulation requires special equipment and is usually used daily for a 30-minute session of intermittent vaginal electrical stimulation (individually adapted on-off cycles are based on a woman's ability to hold a voluntary contraction).

Vaginal "cones" are weighted plastic tampon-like devices that are a crude form of biofeedback; rather than

the audio or visual feedback that a biofeedback machine provides, vaginal cones simply fall out if one is not contracting pelvic muscles adequately. The weights are graduated (20 g, 40 g, and 70 g), so that after successfully retaining a lighter weight, one moves on to heavier ones. Vaginal cones are now sold directly to consumers in catalogs.

For stress incontinence, however, these cones may be unnecessary. In a single-blind, randomized, controlled trial,⁶ 107 women with stress incontinence were randomized to pelvic floor exercises, electrical stimulation, vaginal cones, or a control group (offered a continence guard). Pelvic floor exercises were done at home (8-12 high-intensity contractions three times daily) and in a group setting once weekly with a physical therapist (exercises were done in different positions and included breathing and relaxation exercises).

Outcome measures—subjective and objective—included pelvic floor muscle strength and a pad test with standardized bladder volume (women's bladders were emptied by catheter, then refilled by saline, after which women wore a pre-weighed pad and then ran in place and performed jumping jacks, after which the pad was weighed again). Muscle strength was evaluated by vaginal balloon catheter attached to a transducer. Improvement on muscle strength and reduction in leakage was significantly better after pelvic floor exercises than electrical stimulation or vaginal cones.

Recommendation

Addressing a group of ob-gyns recently, I discovered that although most everyone knows about Kegel exercises, few think of it as an effective treatment for incontinence. Clinical trials, however, are quite consistent in finding a benefit from PFM exercises, with or without biofeedback assistance. Why the discrepancy? The answer may have to do with training.

While some women easily learn to effectively isolate and contract pelvic floor muscles, others may find verbal and written instruction inadequate. Kegel exercises can be taught in the office (for home practice, a woman can provide her own feedback by inserting a finger into her vagina). But if this is not successful after a month, don't jump to the surgical option. Consider referring a patient to a biofeedback therapist (or, alternatively, a physical therapist who specializes in this area).

Biofeedback is clearly an effective tool for teaching proper PFM technique (even Kegel, 50 years ago, utilized a biofeedback device called a perineometer that measured intravaginal pressure). How many women feel confident that they can simultaneously Kegel, decrease intravesical pressure and relax our abdominal muscles?

Not me. (The clinical trials that did not utilize biofeedback utilized extensive training sessions, often with a physical therapist).

Some hospitals and health care organizations already offer biofeedback-assisted PFM programs; if it's not offered in your area, a list of practitioners in your area can be obtained from the Biofeedback Certification Institute of America at (303) 420-2902. ❖

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6. In humans, ingesting dong quai for six months causes estrogenic changes in:

- a. vaginal cells.
- b. endometrium.
- c. All of the above.
- d. None of the above.

7. Photosensitizing furanocoumarins are found in:

- a. dong quai.
- b. celery.
- c. parsley.
- d. All of the above.

8. A recent trial found that for urge incontinence, biofeedback-assisted behavioral treatment was:

- a. superior to oxybutynin.
- b. inferior to oxybutynin.
- c. equivalent to oxybutynin.

9. Although pelvic floor muscle exercises are effective, biofeedback does not appear to supply additional benefit in:

- a. urge incontinence.
- b. stress incontinence.
- c. None of the above.

10. Writing about which of the following was shown to reduce chronic symptoms of asthma or rheumatoid arthritis patients?

- a. Stressful events of the past week
- b. The most stressful event ever experienced
- c. Any subject of the patient's choosing
- d. A time management exercise

Clinical Abstracts

With Comments from Charlea T. Massion, MD

Write On! Patients with Asthma or Rheumatoid Arthritis

Source: Smyth J, et al. Effects of writing about stressful experiences on symptom reduction in patients with asthma and rheumatoid arthritis. *JAMA* 1999;281:1304-1309.

Design and Setting: Oct 1996-Nov 1997 randomized, controlled clinical trial of volunteer, outpatient community residents.

Subjects: Sample of 112 patients with

asthma (n = 61) or rheumatoid arthritis (RA) (n = 51) received the intervention; 107 completed the study (58 asthmatics and 49 arthritics). Mean age of the arthritics was 51.1 years; of the asthmatics, 41.2 years. About 70% of both groups were women. Study subjects had relatively high educational (14 years for both groups) and annual family income (\$65K for arthritics and \$50K for asthmatics) levels. The control and the experimental groups were well matched.

Treatment: All subjects wrote in private 20 min/d for three consecutive days. The experimental group was instructed to write about the most stressful event ever experienced (n = 71; 39 asthma, 32 RA),

while the control group wrote a time management exercise designed to "reduce the day's stress" (n = 41; 22 asthma, 19 RA). The writing tablet was dropped into a sealed box. The writings were read, but never discussed with the subjects.

Outcome Measures: Asthmatics were evaluated with spirometry (FEV₁). Arthritics were clinically examined by a rheumatologist who used a standardized, quantitative method to rate diagnostic symptoms. Assessments were done at baseline, two weeks, two months, and four months after the writing sessions, and were done blind to experimental condition.

Results: Asthmatics in the experimental group showed improvements in lung function at each post-writing assessment, whereas the control group showed no change. Arthritics did not show significant improvement in overall disease activity until the assessment at four months, while the control group showed no change. Combining all the patients who completed the study, 33 (47.1%) of the 70 experimental subjects had clinically relevant improvement, whereas only nine (24.3%) of the 37 control subjects had improvement.

Funding: Fetzer Institute, Kalamazoo, MI.

Comments: Although there has been extensive research on improved health outcomes for healthy people who complete the “most traumatic life event” writing assignment (*see* The Capacity to Confide. In: Dreher H, ed. *The Immune Power Personality: 7 Traits You Can Develop to Stay Healthy*. New York, NY: Penguin Books; 1996), this is the first study of this technique in people with serious chronic illnesses. The outcomes were measured not by indirect tests (blood tests or frequency of physician visits) or by self-reported assessments, but by standard biomedical parameters: For asthmatics, a machine (spirometer); for arthritics, a standardized clinical exam.

David Spiegel, MD, a Stanford psychiatrist who has researched the survival effects of support groups for women with breast cancer, astutely notes in an accompanying editorial, “Were the authors to have provided similar outcome evidence about a new drug, it likely would be in widespread use within a short time. Why? We would think we understood the ‘mechanism’ (whether we did or not) and there would be mediating industry to promote its use. Manufacturers of paper and pencils are not likely to push journaling as a treatment addition for the management of asthma and rheumatoid arthritis.”

However, despite the lack of corporate interest in these interventions, physicians need to pay attention to the growing evidence that an individual’s psychophysiological reactions to an illness can have more impact on the disease outcome than some of our highest-tech drugs, machines and procedures. This study could cast a whole new perspective on the doctor’s waiting room: Do your structured writing there, and then, skip your visit with the physician!—for it’s certainly time to realize that, as Dr. Spiegel clarifies, “it is not simply mind over matter, but it is clear that mind matters.” ❖

From Stress Titers to Influenza Titers: Big Leap for Little Gain

Source: Vedhara, et al. Chronic stress in elderly carers of dementia patients and antibody response to influenza vaccination. *Lancet* 1999; 353:627-631.

Design and Setting: A controlled study of 50 spousal carers (carer is British for caregiver) of dementia patients and 67 controls matched for socioeconomic status. The carer group (including 26 women) served as primary caregivers; cared for their partners at home; and reported no other caregiving responsibilities.

The 67 controls (including 36 women) had living partners without dementia, and they themselves had no caregiving responsibilities for others. None of the carers or controls had end-stage illnesses, and none were receiving treatment, e.g., glucocorticoids or immunosuppressant drugs, that could interfere with cortisol levels or antibody response.

The median age was slightly higher for carers than for controls (73 vs. 68), and the median income somewhat lower (£14,007 vs. £14,128). Both groups had comparable rates of chronic illness.

Methods: All participants were seen at baseline, three months, and six months.

At each visit psychosocial assessments were detailed with elaborate standardized screens. Endocrine assessment was measured at three specified times on one day via cortisol levels in saliva samples. At six months all participants received the 1997/98 trivalent influenza vaccine. IgG antibody response to each of the three influenza strains (Harbin, Nanchang, and Johannesburg) was measured prior to the vaccine on day 0 and on days 7, 14, and 28.

Results: Both the mean scores of emotional distress and the mean cortisol levels were significantly higher in carers than controls at each point before vaccination. Eight (16%) of the carers and 26 (39%) of the controls were “vaccine responders” (defined as those who had a positive response to at least one of the vaccine components). However, the “null responders” (defined as those whose day 0 antibody concentrations to the three strains were equal to or greater than the positive levels for the antibody test method) were a larger group: Harbin, 19 carers, 19 controls; Nanchang, 16 carers, 9 controls; and Johannesburg, 13 carers, 9 controls.

Funding: British Neuroendocrinology Charitable Trust.

Comments: This interdisciplinary study with each discipline contributing a complex component unfortunately does not add up to a significant result, i.e., three mountains moved to create one molehill. We already know that caregivers experience significant stress, and that stress can raise cortisol levels. Also, we know that cortisol can interfere with immune function. But in this study, about 40% of the carers and controls were already immune to at least one of the influenza strains that was used to measure immunity.

My vote: Back to the drawing board for this research group with an assignment to find more substantial results to back their opening claim that “Elderly carers of spouse have increased activation of the hypothalamic-pituitary axis and a poor antibody response to influenza vaccine.” (Show us next time!) ❖