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The role of inflammation in muscle aging

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Bibliography

- Agnew PJ, Maas F (1991) Jamar dynamometer and adapted sphygmomanometer for measuring grip strength in patients with rheumatoid arthritis. *Occup Ther J Res* **11**, 259–270.
- Ali S, Garcia JM (2014) Sarcopenia, cachexia and aging: diagnosis, mechanisms and therapeutic options — a mini-review. *Gerontology* **60**, 294–305.
- Andrassy M, Volz HC, Igwe JC, Funke B, Eichberger SN, Kaya Z, Buss S, Autschbach F, Pleger ST, Lukic IK, Bea F, Hardt SE, Humpert PM, Bianchi ME, Mairbaurl H, Nawroth PP, Remppis A, Katus HA, Bierhaus A (2008) High-mobility group box-1 in ischemia-reperfusion injury of the heart. *Circulation* **117**, 3216–3226.
- Arne M, Janson C, Janson S, Boman G, Lindqvist U, Berne C, Emtner M (2009) Physical activity and quality of life in subjects with chronic disease: chronic obstructive pulmonary disease compared with rheumatoid arthritis and diabetes mellitus. *Scand J Prim Health Care* **27**, 141–147.
- Arnold AP (2009) The organizational-activational hypothesis as the foundation for a unified theory of sexual differentiation of all mammalian tissues. *Horm Behav* **55**, 570–578.
- Arnold L, Henry A, Poron F, Baba-Amer Y, van Rooijen N, Plonquet A, Gherardi RK, Chazaud B (2007) Inflammatory monocytes recruited after skeletal muscle injury switch into antiinflammatory macrophages to support myogenesis. *J Exp Med* **204**, 1057–1069.
- Auger G, Corvec S, Roquilly A, Segain, JP, Lepelletier D, Reynaud A, Asehounne K (2011) Escherichia coli-induced productions of pro-inflammatory cytokines are regulated by MAP kinases and G-protein but

- not by Akt: Relationship with phylogenetic groups and resistance patterns. *Cytokine* **56**, 290–297.
- Aulock SV, Deininger S, Draing C, Gueinzus K, Dehus O, Hermann C (2006). Gender difference in cytokine secretion on immune stimulation with LPS and LTA. *J Interferon Cytokine Res* **26**, 887–892.
- Awomoyi AA, Marchant A, Howson JM, McAdam KP, Blackwell JM, Newport MJ (2002) Interleukin-10, polymorphism in SLC11A1 (formerly NRAMP1), and susceptibility to tuberculosis. *J Infect Dis* **186**, 1808–1814.
- Azevedo ZM, Luz RA, Victal SH, Kurdian B, Fonseca VM, Fitting C, Câmara FP, Haeffner-Cavaillon N, Cavaillon JM, Gaspar Elsas MI, Elsas PX (2005) Increased production of tumor necrosis factor- α in whole blood cultures from children with primary malnutrition. *Braz J Med Biol Res* **38**, 171–183.
- Bain BJ (1996) Ethnic and sex differences in the total and differential white cell count and platelet count. *J Clin Pathol* **49**, 664–666.
- Bain BJ, England JM (1975) Normal haematological values: sex difference in neutrophil count. *Br Med J* **1**, 306–309.
- Balteskard L, Brox JH, Osterud B (1993) Thromboxane production in the blood of women increases after menopause whereas tumor necrosis factor is reduced in women compared with men. *Atherosclerosis* **102**, 91–98.
- Banker BQ, Engel AG (2004) Basic reactions of muscle. In: Engel AG, Franzini-Armstrong C, editors. *Myology: basic and clinical*. (New York: McGraw-Hill) pp. 691–741.
- Barrett JC, Fry B, Maller J, Daly MJ (2005) Haploview: analysis and visualization of LD and haplotype maps. *Bioinformatics* **21**, 263–265.
- Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, *et al.* (1998) Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol* **147**, 755–763.
- Beenakker KG, Ling CH, Meskers CG, de Craen AJ, Stijnen T, Westendorp RG, Maier AB (2010) Patterns of muscle strength loss with age in the general population and patients with a chronic inflammatory state. *Ageing Res Rev* **9**, 431–436.

- Beenakker KG, Westendorp RG, de Craen AJ, Slagboom PE, van Heemst D, Maier AB (2013) Pro-inflammatory capacity of classically activated monocytes relates positively to muscle mass and strength. *Aging Cell* **12**, 682–689.
- Beeson PB (1994) Age and sex associations of 40 autoimmune diseases. *Am J Med* **96**, 457–462.
- Bekkering S, Joosten LA, Meer JW, Netea MG, Riksen NP (2013) Trained innate immunity and atherosclerosis. *Current Opinion Lipidology* **24**, 487–492.
- Bencze M, Negroni E, Vallese D, Yacoub-Youssef H, Chaouch S, Wolff A, Aamiri A, Di Santo JP, Chazaud B, Butler-Browne G, Savino W, Mouly V, Riederer I (2012) Proinflammatory macrophages enhance the regenerative capacity of human myoblasts by modifying their kinetics of proliferation and differentiation. *Mol Ther* **20**, 2168–2179.
- Berres ML, Schnyder B, Yagmur E, Inglis B, Stanzel S, Tischendorf JJ, Koch A, Winograd R, Trautwein C, Wasmuth HE (2009) Longitudinal monocyte human leukocyte antigen-DR expression is a prognostic marker in critically ill patients with decompensated liver cirrhosis. *Liver Int* **29**, 536–543.
- Bianchi ME, Manfredi AA (2009). Immunology. Dangers in and out. *Science*, **323**, 1683–1684.
- Biamond P, Swaak AJ, Koster JF (1984) Protective factors against oxygen free radicals and hydrogen peroxide in rheumatoid arthritis synovial fluid. *Arthritis Rheum* **27**, 760–765.
- Bienvendu J, Doche C, Gutowski MC, Lenoble M, Lepape A, Perdrix JP (1995) Production of proinflammatory cytokines and cytokines involved in the TH1/TH2 balance is modulated by pentoxifylline. *J Cardiovasc Pharmacol* **25** Suppl 2, S80–S84.
- Bijlsma AY, Meskers CG, Ling CH, Narici M, Kurlle SE, Cameron ID, Westendorp RG, Maier AB (2013) Defining sarcopenia: the impact of different diagnostic criteria on the prevalence of sarcopenia in a large middle aged cohort. *Age (Dordrecht, Netherlands)* **35**, 871–881.

- Bijsterbosch J, Meulenbelt I, Watt I, Rosendaal FR, Huizinga TW, Kloppenburg M (2014) Clustering of hand osteoarthritis progression and its relationship to progression of osteoarthritis at the knee. *Ann Rheum Dis* **73**, 567–572.
- Bland JM, Altman DG (1996) The use of transformation when comparing two means. *BMJ* **312**, 1153.
- Bodell PW, Kodesh E, Haddad F, Zaldivar FP, Cooper DM, Adams GR (2009) Skeletal muscle growth in young rats is inhibited by chronic exposure to IL-6 but preserved by concurrent voluntary endurance exercise. *J Appl Physiol* **106** 443–453.
- Boef AG, May L, van Bodegom D, Kuningas M, Eriksson UK, Westendorp RG (2012) The influence of genetic variation on innate immune activation in an environment with high infectious pressure. *Genes Immun* **13**, 103–108.
- Boef AG, May L, van Bodegom D, van Lieshout L, Verweij JJ, Maier AB, Westendorp RG, Eriksson UK (2013) Parasitic infections and immune function: effect of helminth infections in a malaria endemic area. *Immunobiology* **218**, 706–711.
- Boomsma DI, de Geus EJ, Vink JM, Stubbe JH, Distel MA, Hottenga JJ, Posthuma D, van Beijsterveldt TC, Hudziak JJ, Bartels M, Willemsse G (2006) Netherlands Twin Register: from twins to twin families. *Twin Res Hum Genet* **9**, 849–857.
- Botha-Scheepers S, Watt I, Slagboom E, de Craen AJ, Meulenbelt I, Rosendaal FR, Breedveld FC, Huizinga TW, Kloppenburg M (2008) Innate production of tumour necrosis factor α and interleukin 10 is associated with radiological progression of knee osteoarthritis. *Ann Rheum Dis* **67**, 1165–1169.
- Bouman A, Heineman MJ, Faas MM (2005) Sex hormones and the immune response in humans. *Hum Reprod Update* **11**, 411–423.
- Bouman A, Schipper M, Heineman MJ, Faas MM (2004) Gender difference in the non-specific and specific immune response in humans. *Am J Reprod Immunol* **52**, 19–26.

- Borovikova LV, Ivanova S, Zhang M, Yang H, Botchkina GI, Watkins LR, Wang H, Abumrad N, Eaton JW, Tracey KJ (2000) Vagus nerve stimulation attenuates the systemic inflammatory response to endotoxin. *Nature* **405**, 458–462.
- Bruunsgaard H, Pedersen AN, Schroll M, Skinhoj P, Pedersen BK (1999) Impaired production of proinflammatory cytokines in response to lipopolysaccharide (LPS) stimulation in elderly humans. *Clin Exp Immunol* **118**, 235–241.
- Budui SL, Rossi AP, Zamboni M (2015) The pathogenetic bases of sarcopenia. *Clin Cases Miner Bone Metab* **12**, 22–26.
- Bundsuh D, Barsig J, Hartung T, Randow F, Docke WD, Volk HD, Wendel A (1997) Granulocyte-macrophage colony-stimulating factor and IFN- γ restore the systemic TNF- α response to endotoxin in lipopolysaccharide-desensitized mice. *J Immunol* **158**, 2862–2871.
- Cassatella MA (1995). The production of cytokines by polymorphonuclear neutrophils. *Immunol Today* **16**, 21–26.
- Chazaud B (2014) Macrophages: supportive cells for tissue repair and regeneration. *Immunobiology* **219**, 172–178.
- Chen SE, Gerken E, Zhang Y, Zhan M, Mohan RK, Li AS, Reid MB, Li YP (2005) Role of TNF- α signaling in regeneration of cardiotoxin-injured muscle. *Am J Physiol Cell Physiol* **289**, C1179–C1187.
- Chen SE, Jin B, Li YP (2007). TNF- α regulates myogenesis and muscle regeneration by activating p38 MAPK. *Am J Physiol Cell Physiol* **292**, C1660–C1671.
- Choy EH, Panayi GS (2001) Cytokine pathways and joint inflammation in rheumatoid arthritis. *N Engl J Med* **344**, 907–916.
- Clark BC, Manini TM (2008) Sarcopenia \neq dynapenia. *J Gerontol A Biol Sci Med Sci* **63**, 829–834.
- Collaboration IRGCERF: Sarwar N, Butterworth AS, Freitag DF, Gregson J, *et al.* (2012) Interleukin-6 receptor pathways in coronary heart disease: a collaborative meta-analysis of 82 studies. *Lancet* **379**, 1205–1213.

- Coletti D, Moresi V, Adamo S, Molinaro M, Sassoon D (2005) Tumor necrosis factor- α gene transfer induces cachexia and inhibits muscle regeneration. *Genesis* **43**, 120–128.
- Costelli P, Carbo N, Tessitore L, Bagby GJ, Lopez-Soriano FJ, Argiles JM, Baccino FM (1993). Tumor necrosis factor- α mediates changes in tissue protein turnover in a rat cancer cachexia model. *J Clin Invest* **92**, 2783–2789.
- Crowson CS, Liang KP, Thorneau TM, Kremers HM, Gabriel SE (2010) Could accelerated aging explain the excess mortality in patients with seropositive rheumatoid arthritis? *Arthritis Rheum* **62**, 378–382.
- Dahlke E, Schlag R, Langenmayer I, Frankenberger M, Käfferlein E, Subkowski T, Emmerich B, Ziegler?Heitbrock HW (1995) Decreased production of TNF and IL-6 in whole blood of CLL patients. *Am J Hemat* **49**, 76–82.
- Damsgaard CT, Lauritzen L, Calder PC, Kjaer TM, Frokiaer H (2009) Whole-blood culture is a valid low-cost method to measure monocytic cytokines — a comparison of cytokine production in cultures of human whole-blood, mononuclear cells and monocytes. *J Immunol Methods* **340**, 95–101.
- Damsgaard CT, Lauritzen L, Calder PC, Kjaer TR, Frokiaer H (2009b) Reduced ex vivo interleukin-6 production by dietary fish oil is not modified by linoleic acid intake in healthy men. *J Nutr* **139**, 1410–1414.
- Dao HH, Do QT, Sakamoto J (2011) Abnormal body composition phenotypes in Vietnamese women with early rheumatoid arthritis. *Rheumatology (Oxford)* **50**, 1250–1258.
- Dato S, Krabbe KS, Thinggaard M, Pedersen BK, Christensen K, Bruunsgaard H, Christiansen L (2010) Commonly studied polymorphisms in inflammatory cytokine genes show only minor effects on mortality and related risk factors in nonagenarians. *J Gerontol A Biol Sci Med Sci* **65**, 225–235.
- Davey Smith G, Ebrahim S (2003) ‘Mendelian randomization’: can genetic epidemiology contribute to understanding environmental determinants of disease? *Int J Epidemiol* **32**, 1–22.

- De Craen AJ, Posthuma D, Remarque EJ, van den Biggelaar AH, Westendorp RG, Boomsma DI (2005). Heritability estimates of innate immunity: an extended twin study. *Genes Immun* **6**, 167–170.
- Degens H (2010) The role of systemic inflammation in age-related muscle weakness and wasting. *Scand J Med Sci Sports* **20**, 28–38.
- De Groote D, Zangerle PF, Gevaert Y, Fassotte MF, Beguin Y, Noizat-Pirenne F, Pirenne J, Gathy R, Lopez M, Dehart I, Igot D, Baudrihaye M, Delacroix D, Franchimont P (1992) Direct stimulation of cytokines (IL-1 β , TNF- α , IL-6, IL-2, IFN- γ and GM-CSF) in whole blood. I. Comparison with isolated PBMC stimulation. *Cytokine* **4**, 239–248.
- De Jong BA, Schrijver HM, Huizinga TW, Bollen EL, Polman CH, Uitdehaag BM, Kersbergen MC, Sturk A, Westendorp RG (2000) Innate production of interleukin-10 and tumor necrosis factor affects the risk of multiple sclerosis. *Ann Neurol* **48**, 641–646.
- De Jong BA, Huizinga TW, Bollen EL, Uitdehaag BM, Bosma GP, van Buchem MA, Remarque EJ, Burgmans AC, Kalkers NF, Polman CH, Westendorp RG (2002) Production of IL-1 β and IL-1Ra as risk factors for susceptibility and progression of relapse-onset multiple sclerosis. *J Neuroimmunol* **126**, 172–179.
- Deng B, Wehling-Henricks M, Villalta SA, Wang Y, Tidball JG (2012) IL-10 triggers changes in macrophage phenotype that promote muscle growth and regeneration. *J Immunol* **189**, 3669–3680.
- Dennison U, McKernan DP, Scully P, Clarke G, Cryan J, Dinan T (2012). Menstrual cycle influences Toll-like receptor responses. *Neuroimmunomodulation* **19**, 171–179.
- Der Wiel AB, van Exel E, de Craen AJ, Gussekloo J, Lagaay AM, Knook DL, Westendorp RG. (2002) A high response is not essential to prevent selection bias: results from the Leiden 85-plus study. *J Clin Epidemiol* **55**, 1119–1125.
- Desch CE, Kovach NL, Present W, Broyles C, Harlan JM (1989) Production of human tumor necrosis factor from whole blood ex vivo. *Lymphokine Res* **8**, 141–146.

- Desrosiers J, Hébert R, Bravo G, Dutil E (1995) Comparison of the Jamar dynamometer and the Martin vigorimeter for grip strength measurements in a healthy elderly population. *Scand J Rehabil Med* **27**, 137–143.
- De Vries-Bouwstra JK, Goekoop-Ruiterman YP, Wesoly J, Hulsmans HJ, de Craen AJ, Breedveld FC, Dijkmans BA, Allaart CF, Huizinga TW. (2007) Ex vivo interleukin 1 receptor antagonist production on lipopolysaccharide stimulation is associated with rheumatoid arthritis and with joint damage. *Ann Rheum Dis* **66**, 1033–1037.
- De Waal Malefyt R, Abrams J, Bennett B, Figdor CG, de Vries JE (1991) Interleukin 10 (IL-10) inhibits cytokine synthesis by human monocytes: an autoregulatory role of IL-10 produced by monocytes. *J Exp Med* **174**, 1209–1220.
- Doherty TJ (2003) Invited review: Aging and sarcopenia. *J Appl Physiol* **95**, 1717–1727.
- Dombrovskiy VY, Martin AA, Sunderram J, Paz HL (2007) Rapid increase in hospitalization and mortality rates for severe sepsis in the United States: a trend analysis from 1993 to 2003. *Crit Care Med* **35**, 1244–1250.
- Dorresteyn MJ, Draisma A, van der Hoeven JG, Pickkers P (2010) Lipopolysaccharide-stimulated whole blood cytokine production does not predict the inflammatory response in human endotoxemia. *Innate Immun* **16**, 248–253.
- Eachempati SR, Hydo L, Barie PS (1999) Gender-based differences in outcome in patients with sepsis. *Arch Surg* **134**, 1342–1347.
- Edstrom L, Nordemar R (1974) Differential changes in type I and type II muscle fibres in rheumatoid arthritis. A biopsy study. *Scand J Rheumatol* **3**, 155–160.
- Engvall IL, Elkan AC, Tengstrand B, Cederholm T, Brismar K, Hafstrom I (2008) Cachexia in rheumatoid arthritis is associated with inflammatory activity, physical disability, and low bioavailable insulin-like growth factor. *Scand J Rheumatol* **37**, 321–328.
- Eskdale J, Gallagher G, Verweij CL, Keijsers V, Westendorp RG, Huizinga TW (1998) Interleukin 10 secretion in relation to human IL-10 locus haplotypes. *Proc Natl Acad Sci USA* **95**, 9465–9470.

- Ferrucci L, Penninx BW, Volpato S, Harris TB, Bandeen-Roche K, Balfour J, Leveille SG, Fried LP, Md JM (2002) Change in muscle strength explains accelerated decline of physical function in older women with high interleukin-6 serum levels. *J American Geriatrics Society* **50**, 1947–1954.
- Ferreira ML, Sherrington C, Smith K, Carswell P, Bell R, Bell M, Nascimento DP, Máximo Pereira LS, Vardon P (2012) Physical activity improves strength, balance and endurance in adults aged 40–65 years: a systematic review. *J Physiother* **58**, 145–156.
- Filippin LI, Teixeira VN, da Silva MP, Miraglia F, da Silva FS (2015) Sarcopenia: a predictor of mortality and the need for early diagnosis and intervention. *Aging Clin Exp Res* **27**, 249–254.
- Fink B, Egl M, Singer J, Fuerst M, Bubenheim M, Neuen-Jacob E (2007) Morphologic changes in the vastus medialis muscle in patients with osteoarthritis of the knee. *Arthritis Rheum* **56**, 3626–3633.
- Fiori MG, Andreola S, Ladelli G, Scirea MR (1983) Selective atrophy of the type IIb muscle fibers in rheumatoid arthritis and progressive systemic sclerosis (scleroderma). A biopsy histochemical study. *Eur J Rheumatol Inflamm* **6**, 168–181.
- Fish EN (2008) The X-files in immunity: sex-based differences predispose immune responses. *Nat Rev Immunol* **8**, 737–744.
- Flytlie HA, Hvid M, Lindgreen E, Kofod-Olsen E, Petersen EL, Jorgensen A, Deleuran M, Vestergaard C, Deleuran B (2010) Expression of MDC/CCL22 and its receptor CCR4 in rheumatoid arthritis, psoriatic arthritis and osteoarthritis. *Cytokine* **49**, 24–29.
- Foulstone EJ, Huser C, Crown AL, Holly JM, Stewart CE (2004) Differential signalling mechanisms predisposing primary human skeletal muscle cells to altered proliferation and differentiation: roles of IGF-I and TNF- α . *Exp Cell Res* **294**, 223–235.
- Franceschi C, Campisi J (2014). Chronic inflammation (inflammaging) and its potential contribution to age-associated diseases. *J Gerontol A Biol Sci Med Sci* **69** Suppl 1, S4–9.
- Friedland JS, Hartley JC, Hartley CG, Shattock RJ, Griffin GE (1995) Inhibition of ex vivo proinflammatory cytokine secretion in fatal Mycobacterium tuberculosis infection. *Clin Exp Immunol* **100**, 233–238.

- Gabriel P, Cakman I, Rink L (2002). Overproduction of monokines by leukocytes after stimulation with lipopolysaccharide in the elderly. *Exp Gerontol* **37**, 235–247.
- Gao Y, Li Y, Guo X, Wu Z, Zhang W (2012) Loss of STAT1 in bone marrow-derived cells accelerates skeletal muscle regeneration. *PLoS One* **7**, e37656.
- Ghana Health Service (GHS) (2005) Annual Report 2004 Upper East Regional Health Administration.
- Ghana Statistical Service (GSS) (2009) Ghana Demographic and Health Survey 2008. Accra, Ghana: Ghana Statistical Service/Ghana Health Service/ICF Macro, pp. 179–221.
- Goekoop-Ruiterman YP, de Vries-Bouwstra JK, Allaart CF, van Zeben D, Kerstens PJ, J. Hazes MW, Zwinderman AH, Roday HK, Han KH, Westedt ML, Gerards AH, van Groenendael JH, Lems WF, van Krugten MV, Breedveld FC, Dijkmans BA (2005) Clinical and radiographic outcomes of four different treatment strategies in patients with early rheumatoid arthritis (the BeSt study): a randomized, controlled trial. *Arthritis Rheumatism* **52** 3381–3390.
- Gomez-Lopez N, Guilbert LJ, Olson DM (2010) Invasion of the leukocytes into the fetal-maternal interface during pregnancy. *J Leukoc Biol* **88**, 625–633.
- Goodpaster BH, Park SW, Harris TB, Kritchevsky SB, Nevitt M, Schwartz AV, Simonsick EM, Tylavsky FA, Visser M, Newman AB (2006) The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. *J Gerontol A Biol Sci Med Sci* **61**, 1059–1064.
- Hairi NN, Cumming RG, Naganathan V, Handelsman DJ, Le Couteur DG, Creasey H, Waite LM, Seibel MJ, Sambrook PN (2010) Loss of muscle strength, mass (sarcopenia), and quality (specific force) and its relationship with functional limitation and physical disability: the Concord Health and Ageing in Men Project. *J Am Geriatr Soc* **58**, 2055–2062.
- Harting JR, Gleason A, Romberger DJ, Von Essen S. G, Qiu F, Alexis N, Poole JA (2012) Chronic obstructive pulmonary disease patients have

- greater systemic responsiveness to ex vivo stimulation with swine dust extract and its components versus healthy volunteers. *J Toxicol Environ Health A* **75** 1456–1470.
- Heesen M, Bloemeke B, Heussen N, Kunz D (2002) Can the interleukin-6 response to endotoxin be predicted? Studies of the influence of a promoter polymorphism of the interleukin-6 gene, gender, the density of the endotoxin receptor CD14, and inflammatory cytokines. *Crit Care Med* **30**, 664–669.
- Hesselberg J, Yaro JA (2006) An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework. *GeoJournal* **67**, 41–55.
- Hingorani AD, Casas JP (2012) The interleukin-6 receptor as a target for prevention of coronary heart disease: a Mendelian randomisation analysis. *Lancet* **379**, 1214–1224.
- Hofmann SR, Rösen-Wolff A, Tsokos GC, Hedrich CM (2012) Biological properties and regulation of IL-10 related cytokines and their contribution to autoimmune disease and tissue injury. *Clin Immunol* **143**, 116–127.
- Hotchkiss RS, Monneret G, Payen D (2013) Immunosuppression in sepsis: a novel understanding of the disorder and a new therapeutic approach. *Lancet Infect Dis* **13**, 260–268.
- Howard C, Ferrucci L, Sun K, Fried LP, Walston J, Varadhan R, Guralnik JM, Semba RD (2007) Oxidative protein damage is associated with poor grip strength among older women living in the community. *J Appl Physiol* **103**, 17–20.
- Hutter E, Skovbro M, Lener B, Prats C, Rabol R, Dela F, Jansen-Durr P (2007) Oxidative stress and mitochondrial impairment can be separated from lipofuscin accumulation in aged human skeletal muscle. *Aging Cell* **6**, 245–256.
- Iannuzzi-Sucich M, Prestwood KM, Kenny AM (2002) Prevalence of sarcopenia and predictors of skeletal muscle mass in healthy, older men and women. *J Gerontol A Biol Sci Med Sci* **57**, M772–M777.
- Innes E (1999) Hand grip testing: a review of literature. *Aust Occup Ther J* **46**, 120–140.

- Interleukin-6 Receptor Mendelian Randomisation Analysis (IL6RMR) Consortium (2012) The interleukin-6 receptor as a target for prevention of coronary heart disease: a mendelian randomisation analysis. *Lancet* **379**, 1214–1224.
- Jacobson DL, Gange SJ, Rose NR, Graham NM (1997) Epidemiology and estimated population burden of selected autoimmune diseases in the United States. *Clin Immunol Immunopathol* **84**, 223–243.
- Janssen I, Heymsfield SB, Wang ZM, Ross R (2000) Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. *J Appl Physiol* **89** 81–88.
- Johansen KM, Skorpe S, Olsen JO, Osterud B (1999) The effect of red wine on the fibrinolytic system and the cellular activation reactions before and after exercise. *Thromb Res* **96**, 355–363.
- Kadi F, Charifi N, Denis C, Lexell J (2004) Satellite cells and myonuclei in young and elderly women and men. *Muscle Nerve* **29**, 120–127.
- Kadi F, Ponsot E (2010) The biology of satellite cells and telomeres in human skeletal muscle: effects of aging and physical activity. *Scand J Med Sci Sports* **20**, 39–48.
- Kayakabe K, Kuroiwa T, Sakurai N, Ikeuchi H, Kadiombo AT, Sakairi T, Kaneko Y, Maeshima A, Hiromura K, Nojima Y (2012) Interleukin-1beta measurement in stimulated whole blood cultures is useful to predict response to anti-TNF therapies in rheumatoid arthritis. *Rheumatology (Oxford)* **51**, 1639–1643.
- Kamijo R, Le J, Shapiro D, Havell EA, Huang S, Aguet M, Bosland M, Vilcek J (1993). Mice that lack the interferon- γ receptor have profoundly altered responses to infection with *Bacillus Calmette-Guerin* and subsequent challenge with lipopolysaccharide. *J Exp Med* **178**, 1435–1440.
- Kaptoge S, Di Angelantonio E, Pennells L, Wood AM, *et al.* (2012) C-reactive protein, fibrinogen, and cardiovascular disease prediction. *N Engl J Med* **367**, 1310–1320.
- Kim-Fine S, Regnault TR, Lee JS, Gimbel SA, Greenspoon JA, Fairbairn J, Summers K, de Vrijer B (2012) Male gender promotes an increased inflammatory response to lipopolysaccharide in umbilical vein blood. *J Matern Fetal Neonatal Med* **25** 2470–2474.

- Kimura M, Kawahito Y, Obayashi H, Ohta M, Hara H, Adachi T, Tokunaga D, Hojo T, Hamaguchi M, Omoto A, Ishino H, Wada M, Kohno M, Tsubouchi Y, Yoshikawa T (2007) A critical role for allograft inflammatory factor-1 in the pathogenesis of rheumatoid arthritis. *J Immunol* **178**, 3316–3322.
- Kimura D, Totapally BR, Raszynski A, Ramachandran C, Torbati D (2008) The effects of CO₂ on cytokine concentrations in endotoxin-stimulated human whole blood. *Crit Care Med* **36**, 2823–2827.
- Klein SL (2000) The effects of hormones on sex differences in infection: from genes to behavior. *Neurosci Biobehav Rev* **24**, 627–638.
- Klein SL (2012) Sex influences immune responses to viruses, and efficacy of prophylaxis and treatments for viral diseases. *Bioessays* **34**, 1050–1059.
- Kleinnijenhuis J, Quintin J, Preijers F, Joosten LA, Ifrim DC, Saeed S, Jacobs C, van Loenhout J, de Jong D, Stunnenberg HG, Xavier RJ, van der Meer JW, van Crevel R, Netea MG (2012) Bacille Calmette-Guerin induces NOD2-dependent nonspecific protection from reinfection via epigenetic reprogramming of monocytes. *Proc Natl Acad Sci USA* **109**, 17537–17542.
- Koopman JJ, van Bodegom D, Jukema JW, Westendorp RG (2012) Risk of cardiovascular disease in a traditional african population with a high infectious load: a population-based study. *PLoS One* **7**, e46855.
- Krabbe KS, Pedersen M, Bruunsgaard H (2004) Inflammatory mediators in the elderly. *Exp Gerontol* **39**, 687–699.
- Kube D, Rieth H, Eskdale J, Kremsner PG, Gallagher G (2001) Structural characterisation of the distal 5' flanking region of the human interleukin-10 gene. *Genes Immun* **2**, 181–190.
- Kuningas M, May L, Tamm R, van Bodegom D, van den Biggelaar AH, Meij JJ, Frölich M, Ziem JB, Suchiman HE, Metspalu A, Slagboom PE, Westendorp RG (2009) Selection for genetic variation inducing pro-inflammatory responses under adverse environmental conditions in a Ghanaian population. *PLoS One* **4**, e7795.
- Kurreeman FA, Schonkeren JJ, Heijmans BT, Toes RE, Huizinga TW (2004) Transcription of the IL10 gene reveals allele-specific regulation at the mRNA level. *Hum Mol Genet* **13**, 1755–1762.

- Later AF, Maas JJ, Engbers FH, Versteegh MI, Bruggemans EF, Dion RA, Klautz RJ (2009) Tranexamic acid and aprotinin in low- and intermediate-risk cardiac surgery: a non-sponsored, double-blind, randomised, placebo-controlled trial. *Eur J Cardiothorac Surg* **36**, 322–329.
- Lee PH, Macfarlane DJ, Lam TH, Stewart SM (2011). Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. *Int J Behav Nutr Phys Act* **8**, 115.
- Lendemans S, Kreuzfelder E, Rani M, Bayeesh E, Ulrich Schade F, Flohé SB, Waydhas C, Flohé S (2007) Toll-like receptor 2 and 4 expression after severe injury is not involved in the dysregulation of the innate immune system. *J Trauma* **63**, 740–746.
- Leor J, Rozen L, Zuloff-Shani A, Feinberg MS, Amsalem Y, Barbash IM, Kachel E, Holbova R, Mardor Y, Daniels D, Ocherashvilli A, Orenstein A, Danon D (2006). Ex vivo activated human macrophages improve healing, remodeling, and function of the infarcted heart. *Circulation* **114**, 94–100.
- Lefevre N, Corazza F, Duchateau J, Desir J, Casimir G (2012) Sex differences in inflammatory cytokines and CD99 expression following in vitro lipopolysaccharide stimulation. *Shock* **38**, 37–42.
- Lettinga KD, Weijer S, Speelman P, Prins JM, Van Der Poll T, Verbon A (2003) Reduced interferon- γ release in patients recovered from Legionnaires' disease. *Thorax* **58**, 63–67.
- Lexell J, Downham D, Sjöström M (1986) Distribution of different fibre types in human skeletal muscles. Fibre type arrangement in m. vastus lateralis from three groups of healthy men between 15 and 83 years. *J Neurol Sci* **72**, 211–222.
- Lexell J, Taylor CC, Sjoström M (1988) What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. *J Neurol Sci* **84**, 275–294.
- Li Y, Daniel M, Tollefsbol TO (2011) Epigenetic regulation of caloric restriction in aging. *BMC Med* **9**, 98.
- Ling CH, Taekema D, de Craen AJ, Gussekloo J, Westendorp RG, Maier AB (2010) Handgrip strength and mortality in the oldest old population: the Leiden 85-plus study. *CMAJ* **182**, 429-435.

- Ling CH, de Craen AJ, Slagboom PE, Gunn DA, Stokkel MP, Westendorp RG, Maier AB (2011). Accuracy of direct segmental multi-frequency bioimpedance analysis in the assessment of total body and segmental body composition in middle-aged adult population. *Clin Nutr* **30**, 610–615.
- Lindstrom M, Thornell LE (2009) New multiple labelling method for improved satellite cell identification in human muscle: application to a cohort of power-lifters and sedentary men. *Histochem Cell Biol* **132**, 141–157.
- Lodder MC, Schildkamp RL, Bijlmer HA, Dankert J, Kuik DJ, Scholten RJ (1996) Prognostic indicators of the outcome of meningococcal disease: a study of 562 patients. *J Med Microbiol* **45** 16–20.
- Lu H, Huang D, Saederup N, Charo IF, Ransohoff RM, Zhou L (2011a). Macrophages recruited via CCR2 produce insulin-like growth factor-1 to repair acute skeletal muscle injury. *FASEB J* **25**, 358–369.
- Lu H, Huang D, Ransohoff RM, Zhou L (2011b) Acute skeletal muscle injury: CCL2 expression by both monocytes and injured muscle is required for repair. *FASEB J* **25**, 3344–3355.
- Lynch EA, Dinarello CA, Cannon JG (1994) Gender differences in IL-1 α , IL-1 β , and IL-1 receptor antagonist secretion from mononuclear cells and urinary excretion. *J Immunol* **153**, 300–306.
- Madhok R, Crilly A, Watson J, Capell HA (1993) Serum interleukin 6 levels in rheumatoid arthritis: correlations with clinical and laboratory indices of disease activity. *Ann Rheum Dis* **52**, 232–234.
- Magyar E, Talerman A, Mohacsy J, Wouters HW, de Bruijn WC (1977) Muscle changes in rheumatoid arthritis. A review of the literature with a study of 100 cases. *Virchows Arch A Pathol Anat Histol* **373**, 267–278.
- Magyar E, Talerman A, de Bruijn WC, Mohacsy J, Wouters HW (1979) Muscle spindles in rheumatoid arthritis. An ultrastructural study. *Virchows Arch A Pathol Anat Histol* **382**, 191–200.
- Majetschak M, Christensen B, Obertacke U, Waydhas C, Schindler AE, Nast-Kolb D, Schade FU (2000) Sex differences in posttraumatic cytokine release of endotoxin-stimulated whole blood: relationship to the development of severe sepsis. *J Trauma* **48**, 832–839; discussion 9–40.

- Mantovani A, Sozzani S, Locati M, Allavena P, Sica A (2002). Macrophage polarization: tumor-associated macrophages as a paradigm for polarized M2 mononuclear phagocytes. *Trends Immunol* **23**, 549–555.
- Mann CJ, Perdiguero E, Kharraz Y, Aguilar S, Pessina P, Serrano AL, Munoz-Canoves P (2011) Aberrant repair and fibrosis development in skeletal muscle. *Skelet Muscle*. **1**, 21.
- Mauro A (1961) Satellite cell of skeletal muscle fibers. *J Biophys Biochem Cytol* **9**, 493–495.
- May L, van Bodegom D, Kuningas M, Meij JJ, de Craen AJ, Frölich M, Westendorp RG (2009a) Performance of the whole-blood stimulation assay for assessing innate immune activation under field conditions. *Cytokine* **45**, 184–189.
- May L, van den Biggelaar AH, van Bodegom D, Meij HJ, de Craen AJ, Amankwa J, Frölich M, Kuningas M, Westendorp RG (2009b) Adverse environmental conditions influence age-related innate immune responsiveness. *Immun Ageing* **6**, 7.
- McKay JA, Mathers JC (2011) Diet induced epigenetic changes and their implications for health. *Acta Physiol (Oxford)* **202**, 103–118.
- McKean KA, Nunney L (2005). Bateman's principle and immunity: phenotypically plastic reproductive strategies predict changes in immunological sex differences. *Evolution* **59**, 1510–1517.
- McLauchlan GJ, Anderson ID, Grant IS, Fearon KC (1995) Outcome of patients with abdominal sepsis treated in an intensive care unit. *Br J Surg* **82**, 524–529.
- McIlhagger R, Gow AJ, Brett CE, Corley J, Taylor M, Deary IJ, Starr JM (2010) Differences in the haematological profile of healthy 70 year old men and women: normal ranges with confirmatory factor analysis. *BMC Blood Disord* **10**, 4.
- McPhee JS, Hogrel JY, Maier AB, Seppet E, Seynnes OR, Sipilä S, Bottinelli R, Barnouin Y, Bijlsma AY, Gapeyeva H, Maden-Wilkinson TM, Meskers CG, Pääsuke M, Sillanpää E, Stenroth L, Butler-Browne G, Narici MV, Jones DA (2013) Physiological and functional evaluation of healthy young and older men and women: design of the European MyoAge study. *Biogerontology* **14**, 325–337.

- Medzhitov R (2008) Origin and physiological roles of inflammation. *Nature* **454**, 428–435.
- Mege JL, Meghari S, Honstetter A, Capo C, Raoult D (2006) The two faces of interleukin 10 in human infectious diseases. *Lancet Infect Dis* **6**, 557–569.
- Meij JJ, van Bodegom D, Laar B (2007) The Bimoba: the people of Yennu. In: *Testing life history theory in a contemporary African population*, Meij JJ, editor (Leiden, The Netherlands: Leiden University) pp. 25–50.w
- Methe H, Kim JO, Kofler S, Nabauer M, Weis M (2005) Statins decrease Toll-like receptor 4 expression and downstream signaling in human CD14+ monocytes. *Arterioscler Thromb Vasc Biol* **25**, 1439–1445.
- Metter EJ, Talbot LA, Schrager M, Conwit R (2002) Skeletal muscle strength as a predictor of all-cause mortality in healthy men. *J Gerontol A Biol Sci Med Sci* **57**, B359–B365.
- Mills CD, Kincaid K, Alt JM, Heilman MJ, Hill AM (2000). M-1/M-2 macrophages and the Th1/Th2 paradigm. *J Immunol* **164**, 6166–6173.
- Mishra R, Singh A, Chandra V, Negi MP, Tripathy BC, Prakash J, Gupta V (2011). A comparative analysis of serological parameters and oxidative stress in osteoarthritis and rheumatoid arthritis. *Rheumatol Int* **32**, 2377–2382.
- Mitch WE, Goldberg AL (1996) Mechanisms of muscle wasting. The role of the ubiquitin-proteasome pathway. *N Engl J Med* **335**, 1897–1905.
- Moraes MO, Santos AR, Schonkeren JJ, Vanderborght PR, Ottenhoff TH, Moraes ME, Moraes JR, Sampaio EP, Sarno EN, Huizinga TW (2003) Interleukin-10 promoter haplotypes are differently distributed in the Brazilian versus the Dutch population. *Immunogenetics* **54**, 896–899.
- Morel J, Combe B (2005) How to predict prognosis in early rheumatoid arthritis. *Best Pract Res Clin Rheumatol* **19**, 137–146.
- Morley JE, Baumgartner RN, Roubenoff R, Mayer J, Nair KS (2001) Sarcopenia. *J Lab Clin Med* **137**, 231–243.
- Morley JE, Thomas DR, Wilson MM (2006). Cachexia: pathophysiology and clinical relevance. *Am J Clin Nutr* **83**, 735–743.

- Mosser DM, Zhang X (2008) Interleukin-10: new perspectives on an old cytokine. *Immunol Rev* **226**, 205–218.
- Moyer AL, Wagner KR (2011) Regeneration versus fibrosis in skeletal muscle. *Current Opinion in Rheumatology* **23**, 568–573.
- Moxley G, Stern AG, Carlson P, Estrada E, Han J, Benson LL (2004) Premenopausal sexual dimorphism in lipopolysaccharide-stimulated production and secretion of tumor necrosis factor. *J Rheumatol* **31**, 686–694.
- Munoz-Canoves P, Scheele C, Pedersen BK, Serrano AL (2013) Interleukin-6 myokine signaling in skeletal muscle: a double-edged sword? *FEBS J* **280**, 4131–4148.
- Murray HW, Scavuzzo D, Jacobs JL, Kaplan MH, Libby DM, Schindler J, Roberts RB (1987). In vitro and in vivo activation of human mononuclear phagocytes by interferon- γ . Studies with normal and AIDS monocytes. *J Immunol* **138**, 2457–2462.
- Nachtigall I, Tafelski S, Rothbart A, Kaufner L, Schmidt M, Tamarkin A, Kartachov M, Zebedies D, Trefzer T, Wernecke KD, Spies C (2011) Gender-related outcome difference is related to course of sepsis on mixed ICUs: a prospective, observational clinical study. *Crit Care* **15**, R151.
- Nahrendorf M, Pittet MJ, Swirski FK (2010) Monocytes: protagonists of infarct inflammation and repair after myocardial infarction. *Circulation* **121**, 2437–2445.
- Naka T, Nishimoto N, Kishimoto T (2002) The paradigm of IL-6: from basic science to medicine. *Arthritis Research* **4** Suppl 3, S233–S242.
- Nakamura T, Suzuki K (1992) Muscular changes in osteoarthritis of the hip and knee. *Nippon Seikeigeka Gakkai Zasshi* **66**, 467–475.
- Navarro-Xavier RA, Newson J, Silveira VL, Farrow SN, Gilroy DW, Bystrom J (2010). A new strategy for the identification of novel molecules with targeted proresolution of inflammation properties. *J Immunol* **184**, 1516–1525.
- Niessner A, Steiner S, Speidl WS, Pleiner J, Seidinger D, Maurer G, Goronzy JJ, Weyand CM, Kopp CW, Huber K, Wolzt M, Wojta J (2006) Simvastatin suppresses endotoxin-induced upregulation of toll-like receptors 4 and 2 in vivo. *Atherosclerosis* **189**, 408–413.

- Nyugen J, Agrawal S, Gollapudi S, Gupta S (2010) Impaired functions of peripheral blood monocyte subpopulations in aged humans. *J Clin Immunol* **30**, 806–813.
- Nguyen M-H, Cheng M, Koh TJ (2011) Impaired muscle regeneration in ob/ob and db/db mice. *ScientificWorldJournal* **11**, 1525–1535.
- Oertelt-Prigione S (2012) The influence of sex and gender on the immune response. *Autoimmun Rev* **11**, A479–A485.
- Offner PJ, Moore EE, Biffl WL (1999) Male gender is a risk factor for major infections after surgery. *Arch Surg* **134**, 935–938; discussion 8–40.
- Ono S, Tsujimoto H, Hiraki S, Takahata R, Kinoshita M, Mochizuki H (2005). Sex differences in cytokine production and surface antigen expression of peripheral blood mononuclear cells after surgery. *Am J Surg* **190**, 439–444.
- Ouyang Q, Cicek G, Westendorp RG, Cools HJ, van der Klis RJ, *et al.* (2000) Reduced IFN-gamma production in elderly people following in vitro stimulation with influenza vaccine and endotoxin. *Mech Ageing Dev* **121**, 131–137.
- Page TH, Turner JJ, Brown AC, Timms EM, Inglis JJ, Brennan FM, Foxwell BM, Ray KP, Feldmann M (2010) Nonsteroidal anti-inflammatory drugs increase TNF production in rheumatoid synovial membrane cultures and whole blood. *J Immunol* **185**, 3694–3701.
- Payen D, Faivre V, Lukaszewicz AC, Villa F, Goldberg P (2009) Expression of monocyte human leukocyte antigen-DR in relation with sepsis severity and plasma mediators. *Minerva Anestesiologica* **75**, 484–493.
- Pedersen BK, Febbraio MA (2012) Muscles, exercise and obesity: skeletal muscle as a secretory organ. *Nature Rev Endocrinol* **8**, 457–465.
- Piccinni MP, Beloni L, Livi C, Maggi E, Scarselli G, Romagnani S (1998) Defective production of both leukemia inhibitory factor and type 2 T-helper cytokines by decidual T cells in unexplained recurrent abortions. *Nat Med* **4** 1020–1024.
- Pietropaoli AP, Glance LG, Oakes D, Fisher SG (2010) Gender differences in mortality in patients with severe sepsis or septic shock. *Gen Med* **7**, 422–437.

- Popa C, Barrera P, Joosten LA, van Riel PL, Kullberg BJ, van der Meer JW, Netea MG (2009) Cytokine production from stimulated whole blood cultures in rheumatoid arthritis patients treated with various TNF blocking agents. *Eur Cytokine Netw* **20** 88–93.
- Preuss UW, Schuckit MA, Smith TL, Danko GP, Bucholz KK, Hesselbrock MN, Kramer, JR (2003) Predictors and correlates of suicide attempts over 5 years in 1,237 alcohol-dependent men and women. *Am J Psychiatry* **160** 56–63.
- Przybyla B, Gurley C, Harvey JF, Bearden E, Kortebein P, Evans WJ, Sullivan DH, Peterson CA, Dennis RA (2006). Aging alters macrophage properties in human skeletal muscle both at rest and in response to acute resistance exercise. *Exp Gerontol* **41**, 320–327.
- Puzianowska-Kuznicka M, Owczarz M, Wieczorowska-Tobis K, Nadrowski P, Chudek J, Slusarczyk P, Skalska A, Jonas M, Franek E, Mossakowska M (2016) Interleukin-6 and C-reactive protein, successful aging, and mortality: the PolSenior study. *Immun Ageing* **13**, 21.
- Quintin J, Saeed S, Martens JH, Giamarellos-Bourboulis EJ, Ifrim DC, Logie C, Jacobs L, Jansen T, Kullberg BJ, Wijmenga C, Joosten LA, Xavier RJ, van der Meer JW, Stunnenberg HG, Netea MG (2012) *Candida albicans* infection affords protection against reinfection via functional reprogramming of monocytes. *Cell Host & Microbe* **12**, 223–232.
- Randolph GJ (2013) Proliferating macrophages prevail in atherosclerosis. *Nat Med* **19**, 1094–1095.
- Rantanen T, Era P, Heikkinen E (1994) Maximal isometric strength and mobility among 75-year-old men and women. *Age Ageing* **23** 132–137.
- Rantanen T, Masaki K, Foley D, Izmirlian G, White L, Guralnik JM (1998) Grip strength changes over 27 yr in Japanese-American men. *J Appl Physiol* **85**, 2047–2053.
- Rantanen T, Guralnik JM, Sakari-Rantala R, Leveille S, Simonsick EM, Ling S, Fried LP (1999) Disability, physical activity, and muscle strength in older women: the Women's Health and Aging Study. *Arch Phys Med Rehabil* **80** 130–135.

- Rantanen T, Harris T, Leveille SG, Visser M, Foley D, Masaki K, Guralnik JM (2000) Muscle strength and body mass index as long-term predictors of mortality in initially healthy men. *J Gerontol A Biol Sci Med Sci* **55** M168–M173.
- Reardon K, Galea M, Dennett X, Choong P, Byrne E (2001) Quadriceps muscle wasting persists 5 months after total hip arthroplasty for osteoarthritis of the hip: a pilot study. *Intern Med J* **31**, 7–14.
- Reijnierse EM, Trappenburg MC, Leter MJ, Blauw GJ, Sipilä S, Sillanpää E, Narici MV, Hogrel JY, Butler-Browne G, McPhee JS, Gapeyeva H, Pääsuke M, de van der Schueren MA, Meskers CG, Maier AB (2015) The impact of different diagnostic criteria on the prevalence of sarcopenia in healthy elderly participants and geriatric outpatients. *Gerontology* **61**, 491–496.
- Riyazi N, Meulenbelt I, Kroon HM, Ronday KH, Le Graverand MP, Rosendaal FR, Breedveld FC, Slagboom PE, Kloppenburg M (2005) Evidence for familial aggregation of hand, hip, and spine but not knee osteoarthritis in siblings with multiple joint involvement: the GARP study. *Ann Rheum Dis* **64**, 438–443.
- Riemsma RP, Taal E, Rasker JJ, Houtman PM, Van Paassen HC, Wiegman O (1996) Evaluation of a Dutch version of the AIMS2 for patients with rheumatoid arthritis. *Br J Rheumatol* **35**, 755–760.
- Rittersma SZ, Kremer Hovinga JA, Koch KT, Boekholdt SM, van Aken BE, Scheepmaker A, Bax M, Schotborgh CE, Piek JJ, Tijssen JG, Reitsma PH, de Winter RJ (2005) Relationship between in vitro lipopolysaccharide-induced cytokine response in whole blood, angiographic in-stent restenosis, and toll-like receptor 4 gene polymorphisms. *Clin Chem* **51**, 516–521.
- Roberts BJ, Dragon JA, Moussawi M, Huber SA (2012). Sex-specific signaling through Toll-Like Receptors 2 and 4 contributes to survival outcome of Coxsackievirus B3 infection in C57Bl/6 mice. *Biol Sex Differ* **3**, 25.
- Rosas-Ballina M, Goldstein RS, Gallowitsch-Puerta M, Yang L, Valdes-Ferrer SI, Patel NB, Chavan S, Al-Abed Y, Yang H, Tracey KJ (2009) The selective alpha7 agonist GTS-21 attenuates cytokine production in human whole blood and human monocytes activated by ligands for TLR2, TLR3, TLR4, TLR9, and RAGE. *Mol Med* **15**, 195–202.

- Rosenberg IH (1989) Summary comments: epidemiological and methodological problems in determining nutritional status of older persons. *Am J Clin Nutr* **50**, 1231?1233.
- Rosenberg IH (1997) Sarcopenia: origins and clinical relevance. *J Nutr* **127**, 990S–991S.
- Roth SM, Martel GF, Ivey FM, Lemmer JT, Metter EJ, Hurley BF, Rogers MA (2000) Skeletal muscle satellite cell populations in healthy young and older men and women. *Anat Rec* **260**, 351–358.
- Roubenoff R (2000) Sarcopenic obesity: does muscle loss cause fat gain? Lessons from rheumatoid arthritis and osteoarthritis *Ann NY Acad Sci* **904** 553–557.
- Roubenoff R (2009) Rheumatoid cachexia: a complication of rheumatoid arthritis moves into the 21st century. *Arthritis Res Ther* **11**, 108.
- Round J, Matthews Y, Jones D (1980) A quick, simple and reliable histochemical method for ATPase in human muscle preparations. *The Histochemical Journal* **12**, 707–710.
- Roziing MP, Westendorp RG, Maier AB, Wijsman CA, Frölich M, de Craen AJ, van Heemst D (2011) Serum triiodothyronine levels and inflammatory cytokine production capacity. *Age* **34**, 195–201.
- Safdar A, Hamadeh MJ, Kaczor JJ, Raha S, Debeer J, Tarnopolsky MA (2010) Aberrant mitochondrial homeostasis in the skeletal muscle of sedentary older adults. *PLoS One* **5**, e10778.
- Salomonsson S, Lundberg IE (2006). Cytokines in idiopathic inflammatory myopathies. *Autoimmunity* **39**, 177–190.
- Samson MM, Meeuwsen IB, Crowe A, Dessens JA, Duursma SA, Verhaar HJ (2000) Relationships between physical performance measures, age, height and body weight in healthy adults. *Age Ageing* **29**, 235–242.
- Sanchez-Faddeev H, Pijpe J, van der Hulle T, Meij HJ, K JvdG, Slagboom PE, Westendorp RG, de Knijff P (2013) The influence of clan structure on the genetic variation in a single Ghanaian village. *Eur J Hum Genet* **21**, 1134–1139.

- Sarban S, Kocyigit A, Yazar M, Isikan UE (2005) Plasma total antioxidant capacity, lipid peroxidation, and erythrocyte antioxidant enzyme activities in patients with rheumatoid arthritis and osteoarthritis. *Clin Biochem* **38**, 981–986.
- Schaap LA, Pluijm SM, Deeg DJ, Harris TB, Kritchevsky SB, Newman AB, Colbert LH, Pahor M, Rubin SM, Tylavsky FA, Visser M (2009) Higher inflammatory marker levels in older persons: associations with 5-year change in muscle mass and muscle strength. *J Gerontol A Biol Sci Med Sci* **64**, 1183–1189.
- Scheingraber S, Dobbert D, Schmiedel P, Seliger E, Dralle H (2005) Gender-specific differences in sex hormones and cytokines in patients undergoing major abdominal surgery. *Surg Today* **35**, 846–854.
- Schoenmaker M, de Craen AJ, de Meijer PH, Beekman M, Blauw GJ, Slagboom PE, Westendorp RG (2006). Evidence of genetic enrichment for exceptional survival using a family approach: the Leiden Longevity Study. *Eur J Hum Genet.* **14**, 79–84.
- Schroder J, Kahlke V, Staubach KH, Zabel P, Stuber F (1998) Gender differences in human sepsis. *Arch Surg* **133**, 1200–1205.
- Schroder K, Sweet MJ, Hume DA (2006). Signal integration between IFN- γ and TLR signalling pathways in macrophages. *Immunobiology* **211**, 511–524.
- Serhan CN, Chiang N, Van Dyke TE (2008) Resolving inflammation: dual anti-inflammatory and pro-resolution lipid mediators. *Nat Rev Immunol* **8**, 349–361.
- Shepherd J, Blauw GJ, Murphy MB, Cobbe SM, Bollen EL, Buckley BM, Ford I, Jukema JW, Hyland M, Gaw A, Lagaay AM, Perry IJ, Macfarlane PW, Meinders AE, Sweeney BJ, Packard CJ, Westendorp RG, Twomey C, Stott DJ (1999) The design of a prospective study of pravastatin in the elderly at risk (PROSPER). *Am J Cardiol* **84**, 1192–1197.
- Shepherd J, Blauw GJ, Murphy MB, Bollen EL, Buckley BM, Cobbe SM, Ford I, Gaw A, Hyland M, Jukema JW, Kamper AM, Macfarlane PW, Meinders AE, Norrie J, Packard CJ, Perry IJ, Stott DJ, Sweeney BJ, Twomey C, Westendorp R (2002). Pravastatin in elderly individuals at risk of vascular disease (PROSPER): A randomised controlled trial. *Lancet* **360**, 1623–1630.

- Shetty PS, James WPT (1994) Body mass index: a measure of chronic energy deficiency in adults. *FAO Food Nutr Pap* **56**, 1–57.
- Singh T, Newman AB (2011) Inflammatory markers in population studies of aging. *Ageing Res Rev* **10**, 319–329.
- Slatkowsky-Christensen B, Mowinckel P, Loge JH, Kvien TK (2007) Health-related quality of life in women with symptomatic hand osteoarthritis: a comparison with rheumatoid arthritis patients, healthy controls, and normative data. *Arthritis Rheum* **57**, 1404–1409.
- Smeeth L, Thomas SL, Hall AJ, Hubbard R, Farrington P, Vallance P (2004) Risk of myocardial infarction and stroke after acute infection or vaccination. *N Engl J Med* **351**, 2611–2618.
- Smith CJ, Emsley HC, Udeh CT, Vail A, Hoadley ME, Rothwell NJ, Tyrrell PJ, Hopkins SJ (2012) Interleukin-1 receptor antagonist reverses stroke-associated peripheral immune suppression. *Cytokine* **58**, 384–389.
- Solinas G, Germano G, Mantovani A, Allavena P (2009). Tumor-associated macrophages (TAM) as major players of the cancer-related inflammation. *J Leukoc Biol* **86**, 1065–1073.
- Sprague AH, Khalil RA (2009) Inflammatory cytokines in vascular dysfunction and vascular disease. *Biochem Pharmacol* **78**, 539–552.
- Starr JM, Deary IJ (2011). Sex differences in blood cell counts in the Lothian Birth Cohort 1921 between 79 and 87 years. *Maturitas* **69**, 373–376.
- Stephens M, Smith NJ, Donnelly P (2001) A new statistical method for haplotype reconstruction from population data. *Am J Hum Genet* **68**, 978–989.
- Summan M, Warren GL, Mercer RR, Chapman R, Hulderman T, Van Rooijen N, Simeonova PP (2006). Macrophages and skeletal muscle regeneration: a clodronate-containing liposome depletion study. *Am J Physiol Regul Integr Comp Physiol* **290**, R1488–1495.
- Szulc P, Munoz F, Marchand F, Chapurlat R, Delmas PD (2010) Rapid loss of appendicular skeletal muscle mass is associated with higher all-cause mortality in older men: the prospective MINOS study. *Am J Clin Nutr* **91**, 1227–1236.

- Taekema DG, Westendorp RG, Frolich M, Gussekloo J (2007). High innate production capacity of tumor necrosis factor- α and decline of handgrip strength in old age. *Mech Ageing Dev* **128**, 517–521.
- Taekema DG, Gussekloo J, Maier AB, Westendorp RG, de Craen AJ (2010) Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old. *Age Ageing* **39**, 331–337.
- Teixeira CF, Zamuner SR, Zuliani JP, Fernandes CM, Cruz-Hofling MA, Fernandes I, Chaves F, Gutierrez JM (2003). Neutrophils do not contribute to local tissue damage, but play a key role in skeletal muscle regeneration, in mice injected with *Bothrops asper* snake venom. *Muscle & Nerve* **28**, 449–459.
- Thornell LE, Lindstrom M, Renault V, Mouly V, Butler-Browne GS (2003) Satellite cells and training in the elderly. *Scand J Med Sci Sports* **13**, 48–55.
- Tiainen K, Hurme M, Hervonen A, Luukkaala T, Jylha M (2010) Inflammatory markers and physical performance among nonagenarians. *J Gerontol A Biol Sci Med Sci* **65**, 658–663.
- Tidball JG, Wehling-Henricks M (2007). Macrophages promote muscle membrane repair and muscle fibre growth and regeneration during modified muscle loading in mice in vivo. *J Physiol* **578**, 327–336.
- Touno M, Senda M, Nakago K, Yokoyama Y, Inoue H (1996) Muscle fiber changes of the vastus medialis in rheumatoid patients. *Acta Med Okayama* **50**, 157–164.
- Trilok-Kumar G, Arora H, Rajput M, Chellani H, Singh V, Raynes J, Arya S, Aggarwal S, Srivastava N, Sachdev HP, Filteau S (2012) Effect of vitamin D supplementation of low birth weight term Indian infants from birth on cytokine production at 6 months. *Eur J Clin Nutr* **66**, 746–750.
- Trinchieri G (2003). Interleukin-12 and the regulation of innate resistance and adaptive immunity. *Nat Rev Immunol* **3**, 133–146.
- Trompet S, de Craen AJ, Mooijaart S, Stott DJ, Ford I, Sattar N, Jukema W, Westendorp RG (2009) High innate production capacity of proinflammatory cytokines increases risk for death from cancer: Results of the PROSPER study. *Clin Cancer Res* **15**, 7744–7748.

- Van Bodegom D, May L, Meij HJ, Westendorp RG (2007). Regulation of human life histories: the role of the inflammatory host response. *Ann N Y Acad Sci* **1100**, 84–97.
- Van Bodegom D, May L, Kuningas M, Kaptijn R, Thomese F, Meij HJ, Amankwa J, Westendorp RG (2009) Socio-economic status by rapid appraisal is highly correlated with mortality risks in rural Africa. *Trans R Soc Trop Med Hyg* **103**, 795–800.
- Van den Biggelaar AH, Huizinga TW, de Craen AJ, Gussekloo J, Heijmans BT, *et al.* (2004) Impaired innate immunity predicts frailty in old age. The Leiden 85-plus study. *Exp Gerontol* **39**, 1407–1414.
- Van den Biggelaar AH, Gussekloo J, de Craen AJ, Frolich M, Stek ML, van der Mast RC, Westendorp RG (2007) Inflammation and interleukin-1 signaling network contribute to depressive symptoms but not cognitive decline in old age. *Exp Gerontol* **42**, 693–701.
- Van der Linden MW, Huizinga TW, Stoeken DJ, Sturk A, Westendorp RG (1998). Determination of tumour necrosis factor- α and interleukin-10 production in a whole blood stimulation system: assessment of laboratory error and individual variation. *Journal of Immunological Methods* **218**, 63–71.
- Van der Linden MW, Westendorp RG, Sturk A, Bergman W, Huizinga TW (2000) High interleukin-10 production in first-degree relatives of patients with generalized but not cutaneous lupus erythematosus. *J Invest Med* **48**, 327–334.
- Van Eijk LT, Dorresteijn MJ, Smits P, van der Hoeven JG, Netea MG, Pickkers P (2007) Gender differences in the innate immune response and vascular reactivity following the administration of endotoxin to human volunteers. *Crit Care Med* **35**, 1464–1469.
- Van Exel E, Eikelenboom P, Comijs H, Frölich M, Smit JH, Stek ML, Scheltens P, Eefsting JE, Westendorp RG (2009) Vascular factors and markers of inflammation in offspring with a parental history of late-onset Alzheimer disease. *Arch Gen Psychiatry* **66**, 1263–1270.
- Van Exel E, Gussekloo J, de Craen AJ, Bootsma-van der Wiel A, Frolich M, Westendorp RG (2002) Inflammation and stroke: the Leiden 85-Plus Study. *Stroke* **33**, 1135–1138.

- Van Hall G, Steensberg A, Fischer C, Keller C, Møller K, Moseley P, Perdersen BK (2008) Interleukin-6 markedly decreases skeletal muscle protein turnover and increases non muscle amino acid utilization in healthy individuals. *J Clin Endocrinol Metab* **93**, 2851–2858.
- Van Furth AM, Steenwijk TM, Langermans JA, van Furth R (1994). In vitro effect of dexamethasone, pentoxifylline, and anti-endotoxin monoclonal antibody on the release of proinflammatory mediators by human leukocytes stimulated with *Haemophilus influenzae* type B. *Pediatr Res* **35**, 725-728.
- Van Houwelingen HC, Arends LR, Stijnen T (2002) Advanced methods in meta-analysis: multivariate approach and meta-regression. *Stat Med* **21** 589–624.
- Verdijk LB, Koopman R, Schaart G, Meijer K, Savelberg HH, van Loon LJ (2007) Satellite cell content is specifically reduced in type II skeletal muscle fibers in the elderly. *Am J Physiol Endocrinol Metab* **292** E151–E157.
- Vianna LC, Oliveira RB, Araújo CG (2007) Age-related decline in handgrip strength differs according to gender. *J Strength Cond Res* **21**, 1310–1314.
- Villagra A, Sotomayor EM, Seto E (2010) Histone deacetylases and the immunological network: implications in cancer and inflammation. *Oncogene* **29**, 157–173.
- Walsh NP, Gleeson M, Shephard RJ, Gleeson M, Woods JA, Bishop NC, Fleshner M, Green C, Pedersen BK, Hoffman-Goetz L, Rogers CJ, Northoff H, Abbasi A, Simon P (2011) Position statement. Part one: immune function and exercise. *Exerc Immunol Rev* **17**, 6–63.
- Walsmith J, Roubenoff R (2002) Cachexia in rheumatoid arthritis. *Int J Cardiol* **85**, 89–99.
- Wang H, Yu M, Ochani M, Amella CA, Tanovic M, Susarla S, Li JH, Wang H, Yang H, Ulloa L, Al-Abed Y, Czura CJ, Tracey KJ (2003) Nicotinic acetylcholine receptor alpha7 subunit is an essential regulator of inflammation. *Nature* **421**, 384–388.
- Wang Y, Wang YP, Zheng G, Lee VW, Ouyang L, Chang DH, Mahajan D, Coombs J, Wang YM, Alexander SI, Harris DC (2007). Ex vivo programmed macrophages ameliorate experimental chronic inflammatory renal disease. *Kidney Int* **72**, 290–299.

- Warren GL, Hulderman T, Jensen N, McKinstry M, Mishra M, Luster MI, Simeonova PP (2002). Physiological role of tumor necrosis factor α in traumatic muscle injury. *FASEB J* **16**, 1630–1632.
- Warren-Gash C, Smeeth L, Hayward AC (2009) Influenza as a trigger for acute myocardial infarction or death from cardiovascular disease: a systematic review. *Lancet Infect Dis* **9**, 601–610.
- Washburn TC, Medearis DN, Jr., Childs B (1965) Sex Differences in susceptibility to infections. *Pediatrics* **35**, 57–64.
- Weighardt H, Heidecke CD, Emmanuilidis K, Maier S, Bartels H, Siewert JR, Holzmann B *et al.* (2000) Sepsis after major visceral surgery is associated with sustained and interferon-gamma-resistant defects of monocyte cytokine production. *Surgery* **127**, 309–315.
- Westendorp RG, Langermans JA, Huizinga TW, Elouali AH, Verweij CL, Boomsma DI, Vandenbroucke JP (1997) Genetic influence on cytokine production and fatal meningococcal disease. *Lancet* **349**, 170–173.
- Westendorp RG, van Dunne FM, Kirkwood TB, Helmerhorst FM, Huizinga TW (2001) Optimizing human fertility and survival. *Nat Med* **7**, 873.
- Whitacre CC (2001) Sex differences in autoimmune disease. *Nat Immunol* **2**, 777–780.
- Wichmann MW, Inthorn D, Andress HJ, Schildberg FW (2000) Incidence and mortality of severe sepsis in surgical intensive care patients: the influence of patient gender on disease process and outcome. *Intensive Care Med* **26**, 167–172.
- Wijsman CA, Maier AB, de Craen AJ, van den Biggelaar AH, Westendorp RG (2011). An unopposed proinflammatory response is beneficial for survival in the oldest old. Results of the Leiden 85-plus Study. *J Gerontol A Biol Sci Med Sci* **66**, 393–399.
- Wilhelm W, Grundmann U, Rensing H, Werth M, Langemeyer J, Stracke C, Dhingra D, Bauer M (2002) Monocyte deactivation in severe human sepsis or following cardiopulmonary bypass. *Shock (Augusta, Ga.)* **17**, 354–360.
- Williams GC (1957). Pleiotropy, Natural-Selection, and the Evolution of Senescence. *Evolution* **11**, 398–411.

- Wiroth JB, Filippi J, Schneider SM, Al-Jaouni R, Horvais N, Gavarry O, Bermon S, Hebuterne X (2005) Muscle performance in patients with Crohn's disease in clinical remission. *Inflamm Bowel Dis* **11**, 296–303.
- Woods JA, Wilund KR, Martin SA, Kistler BM (2012) Exercise, inflammation and aging. *Aging Dis* **3**, 130–140.
- World Health Organization (WHO) (2003) Diet, nutrition and the prevention of chronic diseases. *World Health Organ Tech Rep Ser* **916**.
- Wroblewski R, Nordemar R (1975) Ultrastructural and histochemical studies of muscle in rheumatoid arthritis. *Scand J Rheumatol* **4**, 197–204.
- Zangerle PF, De GD, Lopez M, Meuleman RJ, Vrindts Y, Fauchet F, Dehart I, Jadoul M, Radoux D, Franchimont P (1992) Direct stimulation of cytokines (IL-1 β , TNF- α , IL-6, IL-2, IFN- γ and GM-CSF) in whole blood: II. Application to rheumatoid arthritis and osteoarthritis. *Cytokine* **4**, 568–575.
- Ziegler-Heitbrock L (2014) Monocyte subsets in man and other species. *Cell Immunol* **289**, 135–139.

